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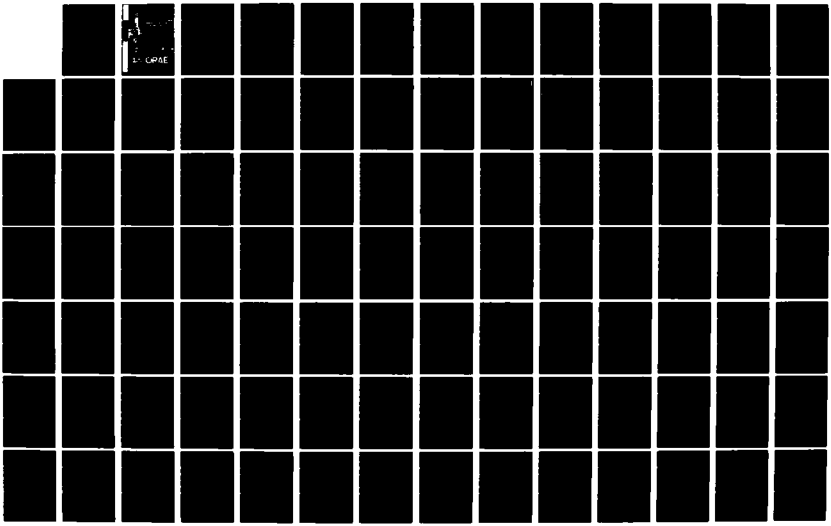

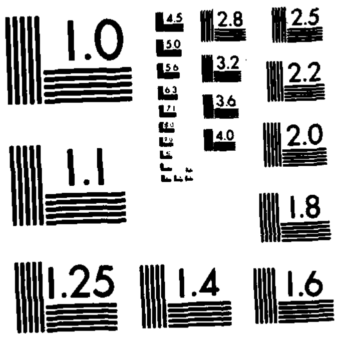

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COMPENDIUM OF ARMS CONTROL VERIFICATION PROPOSALS SECOND EDITION

by
A. CRAWFORD
F.R. CLEMINSON
D.A. GRANT
E. GILMAN

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ORAE ~~REPORT No.~~ R81

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ORAE REPORT NO. 81

COMPENDIUM OF ARMS CONTROL VERIFICATION PROPOSALS

SECOND EDITION

by

A. Crawford

F.R. Cleminson

D.A. Grant

E. Gilman

This report does not necessarily represent the views of the Canadian Department of National Defence.

OTTAWA, CANADA

MARCH 1982

ABSTRACT

This volume is intended to serve as a quick reference catalogue to 296 arms control verification proposals originating in the publications and statements of governments and intergovernmental bodies as well as the academic literature on the subject.

Each proposal has been abstracted and classified according to two main criteria: the arms control objectives with which it is concerned and the types of verification methods involved. Included are a Reference Matrix, a Subject Index and an Author Index which permit easy access by the reader to any proposal abstract in which he or she may be interested.

Chapters in the Compendium are organized according to methods of verification. Each chapter includes an introductory discussion of the method followed by the proposal abstracts which deal prominently with that verification method. A general introduction to the volume is also provided.

RÉSUMÉ

Le présent répertoire est un index permettant de retrouver facilement et rapidement n'importe laquelle des 296 propositions concernant la vérification de la limitation des armes, tirées des publications et des comptes rendus des gouvernements et organismes intergouvernementaux ainsi que des documents didactiques sur le sujet.

Chacune de ces proposition a été condensée et classée en fonction de deux critères principaux: les objectifs de la limitation des armes et les modes de contrôle en cause. Le lecteur pourra, au moyen de la liste de référence, de l'index général et de l'index d'auteurs retrouver facilement tous les condensés de propositions qui l'intéressent.

Les chapitres du volume sont distribués suivant les méthodes de contrôle. Chacun d'eux comprend une analyse préliminaire de la méthode, suivie des condensés des propositions qui s'y rapportent tout particulièrement. Le lecteur trouvera également une introduction générale à cet ouvrage.

PREFACE

The primary research for the Compendium was undertaken by Mr. J. Lamb and Mr. A. Crawford in the summer of 1977. It was substantially revised by the latter author some time after and then edited for official distribution at the Operational Research and Analysis Establishment (ORAE), Department of National Defence, by Mr. G.D. Kaye and Dr. E. Gilman. In June 1980 the amended version was published concurrently as a Canadian contribution to the U.N. Conference of the Committee on Disarmament in Geneva (DC/99) and as an ORAE Report (No. R73). This latest edition of the Compendium is the result of a major revision and updating of the original publication by Mr. Crawford and of the editorial scrutiny of LCol F.R. Cleminson, Mr. D.A. Grant and Dr. Gilman.

The work was conducted under the auspices of the Directorate of Strategic Analysis at ORAE. The following provided invaluable advice and assistance during the early stages of this project: Dr. K.J. Calder, Dr. J.S. Finan, Capt(N) J.D. Toogood and the Arms Control and Disarmament Division, Department of External Affairs. The authors and editors wish to make clear, however, that the views expressed in this volume are theirs alone and in no way can be attributed to either the Department of National Defence or the Canadian Government.

AVANT-PROPOS

Les deux auteurs ont entrepris durant l'été de 1977 le travail de recherche ayant mené à la rédaction du premier répertoire. Ce répertoire a été remanié substantiellement et mis à jour pour sa publication officielle au centre d'Analyse et de Recherch Operationnelle (CAR Op) par MM. G.D. Kaye et E. Gilman. Ensuite, le 12 juin 1980, il a été présenté par le Canada à la conférence du Comité du Désarmement, à Genève, sous le titre abrégé de CD/99 et publié simultanément comme rapport no R73 du (CAR OP). Le répertoire a été revu et augmenté par M. Crawford durant l'hiver et le printemps de 1981, ce qui a donné cette deuxième édition. LCol F.R. Cleminson, M D.A. Grant et Dr. Gilman ont age en tant qu'éditeurs.

Le travail s'est fait sous l'égide du CAR Op/Direction de l'analyse stratégique. Les personnes suivantes ont apporté un précieux concours, par leur aide et leurs conseils, à la rédaction de ce rapport: MM K.J. Calder, J.S. Finan, le capitaine (M) J.D. Toogood et les membres de la Direction du contrôle des armements et du désarmement du ministère des Affaires extérieures. Les auteurs et les réviseurs désirent cependant établir clairement que les opinions exprimées dans le répertoire n'engagent qu'eux-mêmes et ne peuvent en aucune façon être attribuées au ministère de la Défense nationale ou au governement du Canada.

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COMPENDIUM OF ARMS CONTROL VERIFICATION PROPOSALS

INTRODUCTION

THE IMPORTANCE OF VERIFICATION

An arms control agreement is essentially an agreement between states to undertake restrictive measures with regard to their military forces, which are expected to result in decreased likelihood of war. Since the benefit to each assenting state arises from the compliance of the other signatories there is a natural desire for some form of external assurance that these signatories are fulfilling their obligations. In simple terms verification is the means by which such assurance is gained. Consequently the nature of the verification measures associated with an arms control agreement is usually of vital importance both to the successful negotiation of the agreement and to its successful operation once it enters into force. In any protracted arms control negotiations different verification proposals are likely to be made by different participants, and successful negotiation may well depend on an acceptable compromise being reached between these proposals. This appears to be the case for virtually all kinds of prospective arms control topics from general and complete disarmament to control of specific weapon types or limited geographic areas.

It is therefore to be expected that, in the post war years during which arms control negotiations have been almost continuously in progress, large numbers of verification proposals have been put forward from many sources. Many have been made in connection with arms control topics that are still under discussion, if not active negotiation; others have been put together by interested analysts and published in the open literature. Even those proposals which are several years old may remain highly relevant to current conditions.

PURPOSE

This volume is designed with three objectives in mind. The primary aim is to survey as many verification proposals as possible using the records of official bodies and academic literature, with the view to creating a quick reference catalogue which would incorporate summaries of the proposals. The organization of the Compendium mainly reflects this objective.

Two other, secondary aims are also envisaged. One is to provide as complete an historical survey as is feasible. The other is to provide a document which could be used as an introduction for those new to the field, to enable them to acquire a basic grasp of the topic.

This second edition of the Compendium supercedes CD-99 (ORAE REPORT NO. R73) published in June 1980.

SCOPE

Both governmental and non-governmental verification proposals are included in the Compendium. An attempt has been made to incorporate all major, unclassified proposals made by governmental representatives in the Committee on Disarmament, 1979-1980 (CD), the Conference of the Committee on Disarmament, 1970-1978 (CCD), and The Eighteen Nation Committee on

Disarmament, 1962-1969 (ENDC). In addition, arms control treaties and agreements possessing verification provisions have been included. There is no guarantee, however, that all government proposals and agreements have been found.

The review of non-governmental proposals includes those by academics and by international bodies and covers the period from 1962 to 1981 (Spring), though most attention has been given to the last decade. Coverage includes periodical articles, pamphlets, documents and books.

A verification proposal is defined as a statement or document advocating, supporting, rejecting, describing or evaluating a verification system. Only proposals considered to be significantly substantive are abstracted separately. Statements which support or reject a prior proposal are usually appended to the abstract of that proposal. General statements on the need or lack of need for verification are, for the most part, not incorporated into the Compendium. It should be emphasized also that within these limits the Compendium is not intended to include everything said by every country on the issue of verification.

FORMAT OF THE ABSTRACTS

The summary of each verification proposal states:

1) The arms control topic or objective to which the proposal is related.
2) The verification types involved, that is the kind of inspection, observation equipment, monitoring agency or procedures for verifying a signatory's compliance with the proposed arms control agreement.
3) The source document for the proposal and any related documents.
4) A summary of the verification proposal itself, giving a fair representation of the salient points of the verification mechanism proposed.
5) In a few abstracts, selected comments on the proposal by participating states have been added.

ARRANGEMENT

The aim of preparing this volume is to provide access to written information on the subject of arms control verification rather than to pass judgement on the efficacy of the various proposals. However, in view of the large number of proposals it has been necessary to organize the abstracts for easy access. This process has unavoidably involved some degree of subjective decision by the authors, but they have endeavored to keep this to a minimum and to avoid biased statements.

There are various ways in which the summaries could be arranged, however, since verification is the topic of the Compendium, it is this basis which has been chosen. The proposal abstracts are, therefore, distributed into 15 chapters, each dealing with a particular verification method and containing the proposals which are considered to have adopted that method as the most prominent instrument of verification. Within each chapter, abstracts are arranged sequentially according to the categories along the horizontal axis of the "Reference Matrix", that is, by the arms control topic with which they deal. Each chapter begins with a brief introduction describing in general the significant features of the verification method concerned.

Chapters A to D deal with verification by direct on-site inspection of facilities; chapter A general or comprehensive inspection, chapter B selective or partial inspection, chapter C progressive inspection (i.e. increasing as confidence develops), and chapter D with control or observation posts.

Chapter E deals with verification by examination of records.

Chapter F describes proposals for verification by exploiting each individual citizen's conscience to report on possible violations by their own government.

Chapters G to I deal with verification by direct observation, the various instruments used for that purpose and their limitations. Chapter G deals with short-range sensors, chapter H with remote sensors, chapter I with seismic sensors.

Chapters J and K deal with verification by evaluating information either from published documents or from freely exchanged international status reports.

Chapter L covers proposals for verification by national self-supervision or self-inspection.

Chapters M to O deal with the mechanisms for ensuring that suspected violations are given international consideration. They deal respectively with complaints procedures, international control organizations, and review conferences.

CLASSIFICATION BY ARMS CONTROL OBJECTIVES

It is probable that many of the potential users of the Compendium will be concerned with the negotiation of a specific arms control agreement, for example control of the production of chemical weapons. To assist such users a two way classification has been introduced. In addition to the classification by verification method exemplified by the division into chapters, a classification by arms control objective has been made. Examination of the set of proposals indicates seven main arms control objectives or topics, to which we have added a category "any arms control agreement" for cases where the verification method is claimed to have general applicability. With this addition the eight main topics or objectives are as follows:

1. Control of Nuclear Weapons
2. Control of Chemical and Biological Weapons
3. Restrictions on Other Weapons of Mass Destruction
4. Control of Conventional Weapons
5. Regional Arms Control
6. Arms control through Control of Military Expenditures
7. General and Complete Disarmament
8. Any Arms Control Agreement

As might be expected arms control has concentrated heavily, but not exclusively, on the control of actual weapons as is shown by the fact that a very large percentage of the proposals relate to objectives 1, 2 and 4 in the above list. It has therefore been convenient to subdivide these objectives further according to what it is proposed to control. Thus in the case of chemical and biological weapons control might be exercised by monitoring research and development, by controlling production or stockpiling of weapons, or by destroying agreed quantities of weapons or agents. In the case of nuclear weapons control, control is attempted by restriction of research and development, bans on testing, restrictions on nuclear proliferation, control of fissionable materials and control of various types of delivery vehicles. Conventional weapons limitation can relate to weapons used in sea, land or air environments.

With the division into more limited objectives or subobjectives the original list of eight topics or objectives is expanded to the 25 listed in the "Reference Matrix".

THE REFERENCE MATRIX EXPLAINED

The two-way classification by verification method and by arms control objective is displayed in the chart entitled "Reference Matrix" which follows. In the matrix (or table) the column headings list the 25 arms control objectives described above. Down the left side of the matrix the row descriptors list the various verification methods included in the proposal, arranged in the same way as are the chapters. In the boxes formed by the intersection of rows and columns are given the proposal reference numbers for those proposals which employ that particular combination of arms control objective and verification method.

The matrix makes it possible for the reader to turn easily to the relevant verification proposals whether he is interested in a particular arms control problem (in which case he reads down the appropriate column) or in a specific verification method (in which case he reads along the appropriate row).

The matrix also serves to resolve another problem. Many of the verification proposals are complex, perhaps combining several verification methods, or relating to two or more arms control objectives. In the written text such proposals have been placed in the chapter corresponding to the abstractor's assessment of the verification method which is most prominent in the proposal. However, in the matrix it is possible to indicate all the verification methods included in a proposal by putting the proposal reference number in all relevant rows; or if the proposal deals with more than one objective by putting the reference number in each of the relevant columns. The matrix therefore gives a complete and objective picture of the inter-relationships involved in each specific proposal.

Finally, the matrix provides, in a compressed and easily comprehended form, an overview of the history of arms control verification. Those boxes in the matrix where the proposal references are most numerous show clearly the arms control objective verification combinations which have received most attention in the past, and the empty squares indicate combinations which have not yet been seriously considered. Other deductions of some significance can be made by the interested reader; for example looking at the row corresponding to chapter B it is apparent that selective on-site inspection has been considered an appropriate verification method for nearly all arms control objectives; looking down the columns for chemical and biological weapons it can be seen that most of the verification methods so far conceived have been proposed as a means of control, so far without conspicuous success.

It should be noted that certain of the numbers in the matrix are underlined. These refer to the proposal abstracts which deal with existing international agreements or those likely to be of the broadest interest to the reader.

A thesaurus to the terminology used in the matrix is also provided, showing synonymous, hierarchical and other types of cross-references between words and phrases. Use of this thesaurus will help to identify proper subject access terms.

INDEXES

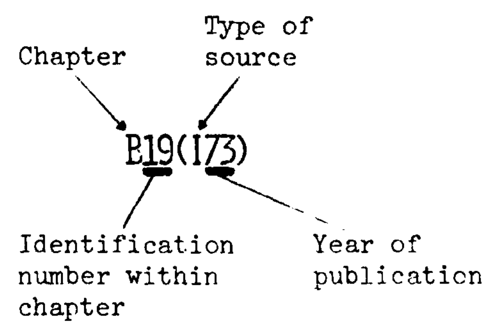
In addition to the Reference Matrix, subject access to the proposals is possible through the Subject Index at the end of the volume. Because of limitations on space, it is not possible to include all potentially useful access points in the matrix; consequently, the Subject Index is included to provide this more detailed subject access.

In addition, an index has been provided to the authors of the proposals. This Author Index covers personal authors, corporate bodies, governments and intergovernment organizations. Finally, a list of working papers by CD, CCD and ENDC document numbers has been included.

REFERENCE NUMBERS

It is possible to glean additional information from the reference numbers apart from the location of the abstract in the Compendium to which they refer. The chapter is indicated by the first letter in the reference number which thus identifies the most prominent type of verification method involved in the proposal. The letter appearing within the brackets identifies the type of source: A for an academic source (usually an individual); G for a governmental source; I for an intergovernmental body; and T to indicate an actual arms control agreement. Finally, the two digits which appear within the brackets following the type of source refer to the year in which the proposal was made.

KEY:



RÉPERTOIRE DES PROPOSITIONS VISANT LA VÉRIFICATION DE LA LIMITATION DES ARMEMENTS

INTRODUCTION

L'IMPORTANCE DE LA VÉRIFICATION

Un accord sur la limitation des armements est essentiellement un arrangement dans le cadre duquel des pays s'engagent les uns vis-à-vis des autres à prendre des mesures visant à limiter leurs forces militaires en vue de diminuer les risques de déclenchement d'une guerre. Comme les bienfaits d'un tel accord pour chaque pays signataire dépendent du respect des dispositions dudit accord par les autres pays signataires, il est normal qu'on veuille s'assurer par des moyens extérieurs que chaque pays respecte ses obligations. En termes simples, disons que la vérification est le moyen grâce auquel on peut obtenir cette assurance. C'est donc dire que la nature des mesures de vérification reliées à un accord sur la limitation des armements revêt généralement une importance vitale pour le succès non seulement des négociations, mais également de l'exécution de l'accord. Tout exercice prolongé de négociations visant un accord de limitation des armements peut donner lieu à diverses propositions de vérification venant de divers participants, et le succès des négociations peut alors fort bien dépendre de la volonté des participants d'en arriver à un compromis. C'est ce qui semble se passer pour pratiquement tous les objets possibles de limitation des armements, du désarmement général et complet jusqu'au contrôle de certains types d'armes ou de zones restreintes.

Il était donc normal que l'on voit mettre de l'avant dans les années d'après-guerre, années au cours desquelles les négociations visant la limitation des armements n'ont presque jamais cessé de progresser, un nombre considérable de propositions de vérification émanant de nombreuses sources. Nombre de ces propositions portaient sur des sujets qui font encore l'objet de discussions, si ce n'est de sérieuses négociations; d'autres ont été réunies par des analystes s'intéressant à la question et elles ont été publiées dans des documents connaissant une diffusion libre. Même les propositions qui remontent à plusieurs années peuvent encore revêtir un immense intérêt dans les conditions actuelles.

BUT

Le présent ouvrage s'inspire de trois objectifs, dont le principal consiste à examiner soigneusement le plus grand nombre possible de propositions de vérification tirées de comptes rendus d'organismes officiels et d'ouvrages didactiques sur le sujet, en vue de dresser un index de consultation facile contenant des résumés des propositions. Le plan du répertoire reflète en grande partie cet objectif.

On vise également deux autres objectifs: d'abord offrir une étude historique aussi complète que possible, et ensuite, mettre à la disposition de ceux qui sont profanes en la matière un ouvrage qui leur permettra de s'initier à la question.

Cette seconde édition du Répertoire remplace le document CD-99 (ORAE REPORT NO. 73) publié en juin 1980.

PORTÉE

Le Répertoire présente des propositions de vérification émanant de milieux tant gouvernementaux que non gouvernementaux. Les auteurs se sont efforcés de rassembler toutes les propositions revêtant une importance majeure parmi les propositions non classifiées, du point de vue de la sécurité, qui ont été mises de l'avant par les représentants de gouvernements en 1979 et en 1980 devant le Comité du désarmement (CD), de 1970 à 1978 devant la Conférence du Comité du désarmement (CCD) et de 1962 à 1969 devant le Comité des dix-huit puissances sur le désarmement (ENDC). On a également tenu compte des traités et des accords sur la limitation des armements qui renferment des dispositions concernant la vérification. Cependant, il n'est pas possible de certifier qu'on a retrouvé la totalité des propositions et des accords gouvernementaux.

L'analyse des propositions émanant de milieux non gouvernementaux a porté sur la période allant de 1962 à 1981 (printemps), bien qu'on se soit concentré davantage sur la dernière décennie; il s'agit de propositions venant de milieux universitaires ainsi que d'organismes internationaux et publiées dans des articles de revues, des opuscules, des dossiers et des livres.

Par proposition de vérification, on entend un exposé ou un document dans lequel on préconise, appuie, rejette, décrit ou évalue un système de vérification. Seules les propositions jugées solides ont fait l'objet d'un condensé. Les exposés appuyant ou rejetant une proposition sont généralement ajoutés au condensé de la proposition en question. La plus grande partie des exposés généraux sur la nécessité ou l'absence des mesures de vérification n'ont pas été incorporés au répertoire. Il faut souligner également que dans le cadre de ces limites, le Répertoire n'a pas été conçu pour consigner tout ce qui a été dit par tous les pays sur la question de la vérification.

FORME DES CONDENSÉS

Chaque résumé de proposition de vérification indique:

1) le sujet ou l'objectif de limitation des armements auquel la proposition se rattache;
2) les méthodes de vérification en cause, c'est-à-dire le genre d'inspection, l'équipement d'observation, l'organisme ou les procédures de surveillance nécessaires pour vérifier jusqu'à quel point un pays signataire respecte l'accord proposé de limitation des armements;

3) le document d'où a été tirée la proposition, et tout document connexe;
4) les grandes lignes (résumé) de la proposition de vérification, donnant une bonne idée des principales caractéristiques des mécanismes de vérification proposés;
5) (dans quelques cas, on a ajouté certaines observations sur la proposition formulées par les pays participants).

DIVISION DE L'OUVRAGE

La publication du présent ouvrage a pour but de rendre accessibles des données écrites sur la vérification de la limitation des armements; il ne s'agit pas d'émettre un jugement sur l'efficacité des diverses propositions. Compte tenu, cependant, du nombre élevé de propositions, il a été nécessaire de présenter les résumés sous une forme facilitant la consultation, ce qui a obligé les auteurs à faire un choix empreint nécessairement d'une certaine subjectivité. Mais ceux-ci se sont efforcés d'éliminer le plus possible cet élément de subjectivité et d'éviter les jugements de parti pris.

On avait le choix entre diverses formules, mais on a retenu la méthode de vérification comme division élémentaire puisque c'est la vérification qui est le thème du répertoire. Les condensés de propositions sont donc répartis en quinze chapitres; chacun de ces chapitres porte sur une méthode particulière de vérification et présente les propositions qui sont censées faire appel à cette méthode comme instrument privilégié de vérification. Les condensés se retrouvant dans chacun des chapitres sont présentés dans l'ordre des rubriques apparaissant en abcisse de la grille de référence, c'est-à-dire suivant le sujet de limitation des armements auquel ils se rapportent. Chaque chapitre commence par une courte introduction décrivant en termes généraux les éléments importants de la méthode de vérification en question.

Les chapitres A à D portent sur la vérification faisant appel à l'inspection directe, in situ, des installations, soit inspection générale ou complète (chapitre A), inspection sélective ou partielle (chapitre B), inspection progressive, c'est-à-dire s'intensifiant au fur et à mesure que la confiance s'installe (chapitre C), et postes de contrôle ou d'observation (chapitre D).

Le chapitre E porte sur la vérification faisant appel à l'examen des dossiers.

Le chapitre F décrit les propositions de vérification faisant appel à la conscience de chaque citoyen ayant le devoir de signaler les cas de violation dont son propre gouvernement pourrait se rendre coupable.

Les chapitres G à I traitent de la vérification au moyen de l'observation directe, et décrivent les divers instruments prévus à cette fin, en précisant leurs limitations: détecteurs à courte portée (chapitre G), dispositifs de télédétection (chapitre H) et détecteurs séismiques (chapitre I).

Les chapitres J et K étudient la vérification faisant appel à l'évaluation des informations tirées soit de publications, soit de rapports de situation échangés librement entre les nations.

Le chapitre L examine les propositions de vérification faisant appel à des mécanismes d'auto-supervision ou d'auto-inspection.

Les chapitres M à O étudient les mécanismes permettant de s'assurer que les cas soupçonnés de violation sont examinés au niveau international. Le chapitre M traite des procédures d'instruction des plaintes, le chapitre N, des organismes internationaux de contrôle, et le chapitre O, des conférences d'examen.

CLASSEMENT PAR OBJECTIFS DE LIMITATION DES ARMEMENTS

Il est probable qu'un grand nombre de ceux qui utiliseront le répertoire voudront se renseigner sur la négociation d'un accord précis de limitation des armements, par exemple, le contrôle de la production des armes chimiques. Pour leur faciliter les choses, on a donc prévu un double classement, c'est-à-dire qu'en plus du classement par méthodes de vérification donnant lieu à la division en chapitres, on trouve un classement par objectifs de limitation des armements. L'examen de la série de propositions révèle sept grands objectifs, ou sujets, de limitation des armements, auxquels on a ajouté la catégorie "tout accord de limitation des armements" pour les cas où la méthode de vérification est réputée avoir une applicabilité générale. Cette addition porte donc à huit les principaux sujets ou objectifs de limitation des armements, qui sont les suivants:

1. Contrôle des armes nucléaires
2. Contrôle des armes chimiques et biologiques
3. Restrictions applicables aux autres armes de destruction massive
4. Contrôle des armes classiques
5. Contrôle des armes au niveau régional
6. Contrôle des armes grâce au contrôle des dépenses militaires
7. Désarmement général et complet
8. Tout accord de limitation des armements.

Comme il était normal que cela se produise, la limitation des armements a porté dans une très grande mesure, mais non exclusivement, sur le contrôle des armes elles-mêmes, puisqu'un nombre considérable de propositions se rattachent aux objectifs 1, 2 et 4 mentionnés plus haut. On a donc pensé qu'il serait utile de subdiviser ces objectifs en fonction de ce qu'il est convenu de contrôler. Dans le cas des armes chimiques et biologiques, par exemple, on pourrait exercer ce contrôle en surveillant les travaux de recherche et de développement, en limitant la production ou le stockage d'armes, ou encore, en détruisant des quantités convenues d'armes ou d'agents. En ce qui concerne les armes nucléaires, le contrôle s'effectue au moyen de restrictions dans le domaine de la recherche et du développement, d'interdictions d'essais, de mesures restrictives visant à empêcher la prolifération des armes nucléaires ainsi que de réglementations applicables aux matières fissiles et à divers types de vecteurs. La limitation des armes classiques peut s'appliquer aux armes utilisées en mer, sur terre et dans les airs.

La subdivision des huit sujets ou objectifs de la liste originale porte donc le nombre de ceux-ci à 25, comme on peut le voir à la grille de référence.

INTERPRÉTATION DE LA GRILLE DE RÉFÉRENCE

Les deux modes de classement, soit selon la méthode de vérification et selon l'objectif de limitation des armements, se retrouvent au tableau intitulé "grille de référence". Dans ce tableau, les rubriques de colonnes reprennent les 25 objectifs de limitation des armements dont il est fait état plus haut. Du côté gauche de la grille, les descripteurs de rangées indiquent les diverses méthodes de vérification prévues dans la proposition, réparties dans le même ordre que les chapitres. Dans les cases formées par la réunion des rangées et des colonnes, on trouve les numéros de référence des propositions qui font appel à cette combinaison particulière d'objectif de limitation des armements et de méthode de vérification.

Grâce à cette grille, le lecteur peut retrouver facilement les propositions de vérification pertinentes, qu'il s'intéresse à un problème précis de limitation des armements (auquel cas il n'a qu'à consulter la colonne appropriée), ou à une méthode de vérification particulière (auquel cas il doit examiner la rangée voulue).

La grille permet également de résoudre un autre problème. Beaucoup de propositions de vérification sont complexes, pouvant combiner plusieurs méthodes de vérification, ou se rattacher à plus de deux objectifs de limitation des armements. Dans le texte, ces propositions ont été placées dans le chapitre correspondant à la méthode de vérification qui, selon l'évaluation du rédacteur, prédomine dans la proposition. Il est cependant possible de signaler dans la grille toutes les méthodes de vérification prévues dans une proposition en indiquant le numéro de référence de la proposition dans toutes les rangées voulues; ou, si la proposition se rattache à plus d'un objectif, en indiquant le numéro de référence dans chacune des colonnes appropriées. La grille donne donc une idée complète et objective des éléments de correspondance qui se retrouvent dans chaque proposition.

Enfin, la grille fournit, sous une forme condensée de compréhension facile, un historique de la vérification de la limitation des armements. Les cases de la grille où les références sont plus nombreuses montrent clairement quelles sont les combinaisons objectif/méthode de vérification de la limitation des armements qui ont retenu davantage l'attention jusqu'ici; quant aux cases vides, elles correspondent à des combinaisons n'ayant pas encore fait l'objet d'études sérieuses. Le lecteur pourra faire d'autres déductions revêtant un certain intérêt; en consultant, par exemple, la rangée correspondant au chapitre B, il se rendra compte immédiatement que l'inspection sélective in situ a été considérée comme une méthode de vérification convenant à la presque totalité des objectifs de limitation des armements; et s'il examine les colonnes de la rubrique des armes chimiques et biologiques, il pourra voir que la plupart des méthodes de vérification proposées jusqu'ici comme moyen de contrôle n'ont pas obtenu beaucoup de succès.

Il est à noter que certains des chiffres qui apparaissent dans la grille sont soulignés. Ils s'appliquent aux condensés de propositions se rattachant à des accords internationaux en vigueur, ou à ceux qui sont susceptibles de présenter un plus grand intérêt pour le lecteur.

L'ouvrage présente également un répertoire des termes utilisés dans la grille, dans lequel on peut trouver des renvois synonymes, hiérarchiques et autres. L'emploi de ce thésaurus permettra au lecteur de relever correctement les termes donnant accès aux sujets.

INDEX

L'accès par sujets est également possible grâce à l'index général qui se trouve à la fin de l'ouvrage. A cause d'un manque d'espace, il n'est pas possible d'inclure dans la grille toutes les formules d'accès utiles. C'est pour assurer cet accès plus poussé par sujets qu'on a prévu un index général.

L'ouvrage comporte en outre un index des auteurs des propositions. Cet index d'auteurs englobe les particuliers, les organismes non gouvernementaux, gouvernementaux et intergouvernementaux. Enfin, on trouvera une liste des documents de travail établis par le Comité du désarmement, la Conférence du Comité du désarmement et le Comité des dix-huit puissances sur le désarmement, et classés par numéros.

NUMÉROS DE RÉFÉRENCE

Les numéros de référence, en plus d'indiquer l'emplacement du condensé de proposition dans le répertoire, permettent également d'obtenir d'autres renseignements. La première lettre du numéro de référence indique le chapitre, précisant par le fait même la méthode de vérification qui prédomine dans la proposition. La lettre apparaissant entre parenthèses désigne la catégorie de la source, soit A pour les milieux d'enseignement (un particulier, en général), G pour les milieux gouvernementaux, I pour les organismes intergouvernementaux, et T s'il s'agit d'un accord réel de limitation des armements. Enfin, les deux chiffres apparaissant entre parenthèses après la mention de la source indiquent l'année au cours de laquelle la proposition a été présentée.

CLÉ

Chapitre

Catégorie de source

B19 (I73)

Numéro d'identification dans le chapitre

Année de publication

LIST OF ABBREVIATIONS

ABM	- Anti-Ballistic Missile
ALCM	- Air Launched Cruise Missile
ASBM	- Air-to-Surface Ballistic Missile
BMEWS	- Ballistic Missile Early Warning System
BW	- Biological Weapon/Warfare
CBM	- Confidence Building Measure
CCD	- Conference of the Committee on Disarmament
CD	- Committee on Disarmament
CBW	- Chemical and Biological Weapon/Warfare
CW	- Chemical Weapon/Warfare
CTB	- Comprehensive Test Ban
ELINT	- Electronic Intelligence
ENDC	- Eighteen Nation Committee on Disarmament
ENMOD	- Environmental Modification
EW	- Early Warning
FOBS	- Fractional Orbital Bombardment System
GCD	- General and Complete Disarmament
GLCM	- Ground Launched Cruise Missile
GTS	- Global Telecommunications System
IAEA	- International Atomic Energy Agency
IDO	- International Disarmament Organization
ISMA	- International Satellite Monitoring Agency
kt	- Kiloton (TNT equivalent)
m_b	- seismic magnitude of body wave (short period P waves) measured on Richter scale
M_s	- seismic magnitude of surface waves (Rayleigh waves)
MARV	- Manoeuvrable Reentry Vehicle
MBFR	- Mutual and Balanced Force Reduction (Talks)
MIRV	- Multiple Independent(ly) (Targeted) Reentry Vehicle
MRV	- Multiple Reentry Vehicle
NPT	- Non-Proliferation Treaty
NTMs	- National Technical Means
NWFZ	- Nuclear Weapons Free Zones
OAS	- Organization of American States
OPANAL	- Agency for the Prohibition of Nuclear Weapons in Latin America
OTH	- "Over-The-Horizon"(Radar)
PNEs	- Peaceful Nuclear Explosions
PRC	- People's Republic of China
SALT	- Strategic Arms Limitation Talks
SIPRI	- Stockholm International Peace Research Institute
SLBM	- Submarine Launched Ballistic Missile
SLCM	- Sea Launched Cruise Missile
TTBT	- Threshold Test Ban Treaty
UN	- United Nations
UNEF	- United Nations Emergency Force
UNEP	- United Nations Environment Program
UNGA	- United Nations General Assembly
WEU	- Western European Union
WHO	- World Health Organization
WMO	- World Meteorological Organization
WWSSN	- World-Wide Standardized Seismograph Network

…ONTROL OBJECTIVES

NUCLEAR WEAPONS

DELIVERY SYSTEM TECHNOLOGY						
BALLISTIC MISSILES	MOBILE BALLISTIC MISSILES	REENTRY VEHICLES	CRUISE MISSILES	MISSILE TESTS	ANTI-BALLISTIC MISSILE SYSTEMS	MANNED AIRCRAFT
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KEY:

CHAPTER → B19(I73) ← SOURCE TYPE

IDENTIFICATION NUMBER WITHIN CHAPTER — YEAR OF PUBLICATION

SOURCE TYPE CODES:

- A = ACADEMIC
- G = GOVERNMENT
- I = INTERGOVERNMENTAL BODY
- T = TREATY

ARMS CONTROL [illegible]

NUCLEAR W[illegible]S

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ARMS CONTROL OBJECTIVES

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B58(G81) H36(G72) H37(G76) H38(G77) L1 (G70)	B42(G79) L9 (G73) B44(A80) M8 (G80) B45(G80) B53(A79) H38(G77) J1 (G73) L1 (G70)	B42(G79) B53(A79) H38(G77) L1 (G70) M8 (G80)	B44(A80) H39(A80) B45(G80) L1 (G70) B53(A79) L9 (G73) B56(A80) M8 (G80) B57(A80) B58(G81) H38(G77)		A3 (G70) A12(T75) A14(T79) B59(A62) H34(A78) H40(A74) H41(A74)	A3 (G70) A14(T79)	A14(T79) H42(A75)	A2 (A78) A17(G69) A3 (G70) A18(G69) A6 (G63) B59(A62) A11(T59) B61(A63) A12(T75) B64(A77) A13(A78) H16(A80) A14(T79) H43(A74)
H38(G77) K3 (G70) L1 (G70) L4 (A73)	J1 (G73) J2 (G78) K3 (G70) L10(G73)	K3 (G70)	K3 (G70)					
B47(G81) G5 (G71) K3 (G70) K4 (A72) K8 (G76) L1 (G70) L4 (A73)	B40(A74) G5 (G71) K9 (G76) L12 (A80) B43(A80) K3 (G70) L1 (G70) M1 (G71) B45(G80) K4 (A72) L5 (G72) M7 (G79) B46(G80) L7 (G70) M8 (G80) B47(G81) L9 (G73) N5 (G80) B55(G79) L10(G73) B58(G81) L11(G74)	B43(A80) K9 (G76) B46(G80) L1 (G70) B47(G81) L11(G74) B58(G81) M7 (G79) G5 (G71) M8 (G80) K3 (G70) N5 (G80) K6 (A80)	L8 (A73) M8 (G80) B55(G79) L9 (G73) N5 (G80) K3 (G70) L10(G73) K6 (A80) L11(G74) K7 (G72) L12(A80) L1 (G70) M1 (G71) L7 (G70) M7 (G79)	H10(G75)	A4 (A61) H40(A74)			A11(T59) A21(T67) H40(A74) H44(A78)
G58(G81) G5 (G71) L1 (G70) L4 (A73) L6 (G69)	B58(G81) L3 (G75) L12 (A80) E4 (A73) L5 (G72) M1 (G71) E5 (G74) L6 (G69) M5 (T72) G5 (G71) L7 (G70) M6 (I80) K9 (G76) L9 (G73) M7 (G79) L1 (G70) L10(G73) M8 (G80) L2 (G72) L11(G74)	G5 (G71) M7 (G79) K9 (G76) M8 (G80) L1 (G70) L6 (G69) L11(G74) M5 (T72) M6 (I80)	K9 (G76) L11(G74) L1 (G70) L12(A80) L6 (G69) M1 (G71) L7 (G70) M5 (T72) L8 (A73) M6 (I80) L9 (G73) M7 (G79) L10(G73) M8 (G80)	L13(G74) L14(G75) M11(T77) M12(G79)				B63(I76)
B58(G81) K3 (G70) L1 (G70) L6 (G69) M4 (G69)	B46(G80) K9 (G76) M1 (G71) M8 (G80) B58(G81) L1 (G70) M2 (G68) N3 (G71) C5 (G79) L5 (G72) M3 (G72) N5 (G80) J1 (G73) L6 (G69) M4 (G69) K3 (G70) L7 (G70) M5 (T72) K5 (G72) L9 (G73) M6 (I80) K7 (G72) L11(G74) M7 (G79)	B46(G80) L11(G74) B58(G81) M4 (G69) C5 (G79) M5 (T72) K3 (G70) M6 (I80) K9 (G76) M7 (G79) L1 (G70) M8 (G80) L6 (G69) N5 (G80)	B58(G81) L7 (G70) M7 (G79) C5 (G79) L9 (G73) M8(G80) K3 (G70) L11(G74) N5 (G80) K7 (G72) M1 (G71) K9 (G76) M4 (G69) L1 (G70) M5 (T72) L6 (G69) M6 (I80)	L13(G74) L14(G75) M9 (G75) M10(G76) M11(T77) M12(G79)	A12(T75) A14(T79)	A14(T79)	A14(T79) H42(A75)	A11(T59) A19(G69) A12(T75) A20(T71) A13(A78) B62(T67) A14(T79) B63(I76) A15(T73) H42(A75) A17(G69) H44(A78) A18(G69) M13(I80)
B58(G81) K3 (G70) L1 (G70)	B38(A70) E5 (G74) L1 (G70) M2 (G68) B41(G79) J1 (G73) L5 (G72) M3 (G73) B45(G80) K3 (G70) L7 (G70) M7 (G79) B46(G80) K5 (G72) L9 (G73) M8 (G80) B53(A79) K7 (G72) L11(G74) N3 (G71) B58(G81) K8 (G76) L12(A80) N4 (G79) C5 (G79) K9 (G76) M1 (G71) N5 (G80)	B46(G80) L11(G74) B53(A79) M7 (G79) B58(G81) M8 (G80) C5 (G79) N4 (G79) K3 (G70) N5 (G80) K9 (G76) L1 (G70)	B45(G80) K9 (G76) M7 (G79) B53(A79) L1 (G70) M8 (G80) B58(G81) L7 (G70) N4 (G79) C5 (G79) L9 (G73) N5 (G80) K3 (G70) L11(G74) K7 (G72) L12(A80) K8 (G76) M1 (G71)	M10(G76) M11(T77)	B59(A62) N7 (G80)	N7(G80)	N7(G80)	A15(T73) B60(A62) B62(T67) B63(I76) F2 (A62) N6 (A76)
L6 (G69)	B46(G80) M6 (I80) K7 (G72) M7 (G79) K9 (G76) L6 (G69) L9 (G73) L11(G74)	B46(G80) K9 (G76) L6 (G69) L11(G74) M5 (T72) M6 (I80)	K7 (G72) M7 (G79) K9 (G76) L6 (G69) L9 (G73) L11(G74) M5 (T72)	L13(G74) M11(T77) M12(G79)				A11(T59) A17(G69) A18(G69) A20(T71)

REFERENCE MATRIX

ARMS CONTROL OBJECTIVES

KEY:

CHAPTER → B10(T73) ← SOURCE TYPE
IDENTIFICATION NUMBER WITHIN CHAPTER — YEAR OF PUBLICATION

SOURCE TYPE CODES:

- A = ACADEMIC
- G = GOVERNMENT
- I = INTERGOVERNMENTAL BODY
- T = TREATY

...RUCTION ...ACILITIES ...R STOCKS	OTHER WEAPONS OF MASS DESTRUCTION	CONVENTIONAL WEAPONS: GROUND FORCES	CONVENTIONAL WEAPONS: AIRCRAFT	CONVENTIONAL WEAPONS: SHIPS	REGIONAL ARMS CONTROL	MILITARY BUDGETS	GENERAL AND COMPLETE DISARMAMENT	ANY ARMS CONTROL AGREEMENT	VERIFICATION PROPOSALS
		A3 (G70) A4 (A61) A12(T75) A14(T79)	A3 (G70) A14(T79)	A14(T79)	A2 (A78) A10(A66) A17(G69) A3 (G70) A11(T59) A18(G69) A5 (A62) A12(T75) A19(G69) A6 (G63) A13(A78) A20(T71) A7 (A7?) A3 (G70) A21(T67) A8 (A78) A15(T73) A9 (A74) A16(G69)		A22(A63) A23(A62) C10(A64) N8 (G61) N9 (G62)	A24(A58) A25(A65) E8 (A63) N12(A65)	CHAPTER A GENERAL
G8 (G71) L11(G74) H39(A80) M1 (G71) K7 (G72) M7 (G79) K8 (G76) M8 (G80) K9 (G76) N4 (G79) L1 (G70) L9 (G73)		A3 (G70) A14(T79) B59(A62)	A3 (G70) A14(T79)	A14(T79)	A3 (G70) A3 (G70) B60(A62) B61(A63) B62(T67) B63(I76) B64(A77)	J4 (I74) J6 (A75)	A23(A62) B65(A62) C10(A64) J7 (A62) K11(A55) K13(A64) N10(G62)	B66(A58) H47(G76) B67(A58) K15(A65) B68(A61) N13(A68) B69(A65) B70(A68) B71(A76) E7 (A63)	CHAPTER B SELECTIVE
					D1(A64)		C6 (A62) K12(A63) C7 (A62) N10(G62) C8 (A62) C9 (A63) C10(A64) C11(A65) H46(A68)		CHAPTER C PROGRESSIVE/ ZONAL
		A3 (G70) A12(T75) A14(T79) H40(A74)	A3 (G70) A14(T79)	A14(T79)	A3 (G70) H40(A74) A6 (G63) H43(A76) A8 (A78) M13(I80) A12(T75) A14(T79) D1 (A64) D2 (A65)		C6 (A62) H45(G57) N10(G62)		CHAPTER D CONTROL POSTS
					A6 (G63)	J4(I74)	C9(A63 J7(A62 N9(G62	E7 (A63) E8 (A63) E9 (A65) K14(A62)	CHAPTER E RECORDS MONITORING
					F2(A62)		F2(A62)	F3 (A61) F4 (A61) F5 (A62) F6 (A63) F7 (A63) F8 (A63) N17(G78)	CHAPTER F NON-PHYSICAL/ PSYCHOLOGICAL INSPECTION
L10(G73) L12(A80) N4 (G79)		A3 (G70) A12(T75) A14(T79)	A3 (G70) A14(T79)		A3 (G70) A12(T75) A13(A78) A14(T79)			G11(A78)	CHAPTER G SHORT-RANGE SENSORS
		A3 (G70) A12(T75) A14(T79) B59(A62) H34(A78) H40(A74) H41(A74)	A3 (G70) A14(T79)	A14(T79) H42(A75)	A2 (A78) A17(G69) H42(A75) A3 (G70) A18(G69) H43(A76) A6 (G63) B60(A62) H44(A78) A11(T59) B61(A63) M13(I80) A12(T75) B64(A77) A13(A78) H16(A80) A14(T79) H40(A74)	J4(I74)	A22(A63) N10(G62) C7 (A62) C9 (A63) C10(A64) H45(G57) H46(A68) N9 (G62)	E8 (A63) H47(G76) H48(A77) H49(G78) H50(A80) H51(A80) N15(A74)	CHAPTER H REMOTE SENSORS
									CHAPTER I SEISMIC SENSORS
						J3(A68) J4(I76) J5(A75) J6(A75)	J7(A62)	E7 (A63) E8 (A63) F8 (A63) J8 (A58) N15(A74)	CHAPTER J LITERATURE SURVEY
M8 (G80) N5 (G80)	K10(G75)	A4 (A61) H40(A74)			A11(T59) A21(T67) H40(A74) H44(A78)	J4(I76) J5(A75) J6(A75)	A23(A62) N10(G62) C6 (A62) C10(A64) K11(A55) K12(A63) K13(A64) N9 (G62)	A24(A68) N14(G73) H47(G76) N15(A74) H48(A77) H49(G78) K14(A62) K15(A65) M14(A77)	CHAPTER K INTERNATIONAL EXCHANGE OF INFORMATION
	L13(G74) L14(G75) M11(T77) M12(G79)				B63(I76)				CHAPTER L NATIONAL SELF SUPERVISION
M7 (G79) M8(G80) N5 (G80)	L13(G74) L14(G75) M9 (G75) M10(G76) M11(T77) M12(G79)	A12(T75) A14(T79)	A14(T79)	A14(T79) H42(A75)	A11(T59) A19(G69) A12(T75) A20(T71) A13(A78) B62(T67) A14(T79) B63(I76) A15(T73) H42(A75) A17(G69) H44(A78) A18(G69) M13(I80)		K11(A55) K13(A64) N9 (G62)	M14(A77) N3 (G71) N13(A68) N14(G73) N15(A74)	CHAPTER M COMPLAINTS PROCEDURE
M7 (G79) M8 (G80) N4 (G79) N5 (G80)	M10(G76) M11(T77)	B59(A62) N7 (G80)	N7(G80)	N7(G80)	A15(T73) B60(A62) B62(T67) B63(I76) F2 (A62) N6 (A76)	J3(A68)	A23(A62) N10(G62) C6 (A62) C10(A64) F2 (A62) K13(A64) N8 (G61) N9 (G62)	A24(A68) N11(A62) N18(G78) F3 (A61) N12(A65) F4 (A61) N13(A68) H47(G76) N14(G73) H49(G78) N15(A74) H51(A80) N16(A78) N3 (G71) N17(G78)	CHAPTER N INTERNATIONAL CONTROL ORGANIZATIONS
	L13(G74) M11(T77) M12(G79)				A11(T59) A17(G69) A18(G69) A20(T71)				CHAPTER O REVIEW CONFERENCES

VERIFICATION PROPOSALS: ON-SITE INSPECTION (Chapters A–D); SENSORS (Chapters G–I); INTRUSIVE (Chapters A–H); NON-INTRUSIVE (Chapters H–L); ANCILLARY ELEMENTS OF VERIFICATION PROPOSALS (Chapters M–O)

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THESAURUS OF SUBJECT TERMINOLOGY USED IN THE REFERENCE MATRIX AND SUBJECT INDEX

The following thesaurus shows synonymous, hierarchical and other relationships between subject terms used in The Reference Matrix and the Subject Index. Many of the specific subdivisions will not be found in the matrix; however, all subject terms listed here are used in the Subject Index at the end of this volume. Those terms which are used in the matrix are marked with an astrix.

Abbreviations:

Symbol	Meaning
Use	Use indicated term
UF	Used for
BT	Broader term
NT	Narrower term
RT	Related term
SN	Scope note

Anti-satellite weapons svstems
Use **REGIONAL ARMS CONTROL - OUTER SPACE**

*ANY ARMS CONTROL AGREEMENT

Ballistic missiles
Use **NUCLEAR WEAPONS - BALLISTIC MISSILES**

BIOLOGICAL WEAPONS
BT Chemical and biological weapons
RT Chemical weapons

BIOLOGICAL WEAPONS - DESTRUCTION OF STOCKS
SN Includes destruction of biological agents and munitions

BIOLOGICAL WEAPONS - PRODUCTION
SN Includes production of biological agents and vectors, as well as the filling of munitions

BIOLOGICAL WEAPONS - PROLIFERATION

BIOLOGICAL WEAPONS - RESEARCH AND DEVELOPMENT

BIOLOGICAL WEAPONS - STOCKPILING
SN Includes stockpiling of biological agents, vectors and munitions

Black boxes
Use SHORT-RANGE SENSORS - MONITORING DEVICES

Budgetary analysis
Use LITERATURE SURVEY - BUDGETARY ANALYSIS

*CHEMICAL AND BIOLOGICAL WEAPONS
NT Chemical weapons
Biological weapons

*CHEMICAL AND BIOLOGICAL WEAPONS - DESTRUCTION OF STOCKS
SN Includes destruction of agents, vectors and munitions

*CHEMICAL AND BIOLOGICAL WEAPONS - PRODUCTION
SN Includes production of agents and the filling of munitions

CHEMICAL AND BIOLOGICAL WEAPONS - PROLIFERATION

*CHEMICAL AND BIOLOGICAL WEAPONS - RESEARCH AND DEVELOPMENT

*CHEMICAL AND BIOLOGICAL WEAPONS - STOCKPILING
SN Includes stockpiling of agents and munitions

CHEMICAL WEAPONS
BT Chemical and biological weapons
RT Biological weapons

CHEMICAL WEAPONS - DESTRUCTION OF FACILITIES
SN Includes destruction, conversion to peaceful uses or "mothballing" of agent production plants and munition filling plants

CHEMICAL WEAPONS - DESTRUCTION OF STOCKS
SN Includes destruction of chemical agents and munitions

CHEMICAL WEAPONS - PRODUCTION
SN Includes production of chemical agents and the filling of munitions

CHEMICAL WEAPONS - PROLIFERATION

CHEMICAL WEAPONS - RESEARCH AND DEVELOPMENT

CHEMICAL WEAPONS - STOCKPILING
SN Includes stockpiling of both chemical agents and munitions

*COMPLAINTS PROCEDURE

COMPLAINTS PROCEDURE - CONSULTATION AND COOPERATION
SN Includes provisions for consulting with other parties bilaterally, multilaterally or through international organizations

COMPLAINTS PROCEDURE - CONSULTATIVE COMMISSION

COMPLAINTS PROCEDURE - REFERRAL TO (existing international body)
SN Subdivided by name of the international body,
e.g. COMPLAINTS PROCEDURE - REFERRAL TO SECURITY COUNCIL

COMPLAINTS PROCEDURE - REFERRAL TO NEW INTERNATIONAL BODY

*CONVENTIONAL WEAPONS

*CONVENTIONAL WEAPONS - AIRCRAFT

*CONVENTIONAL WEAPONS - GROUND FORCES

*CONVENTIONAL WEAPONS - SHIPS

Costs
Use FINANCES

Cruise missiles
Use NUCLEAR WEAPONS - CRUISE MISSILES

Environmental modification weapons
Use OTHER WEAPONS OF MASS DESTRUCTION - ENVIRONMENTAL MODIFICATION

FINANCES
SN Includes explicit substantive discussions of monetary costs or financing of a verification system
UF Costs

Fiscal analysis
Use LITERATURE SURVEY - BUDGETARY ANALYSIS

*GENERAL AND COMPLETE DISARMAMENT

Intelligence methods
Use REMOTE SENSORS

*INTERNATIONAL CONTROL ORGANIZATION

*INTERNATIONAL EXCHANGE OF INFORMATION
RT Literature survey
Records monitoring

INTERNATIONAL EXCHANGE OF INFORMATION - DECLARATIONS

INTERNATIONAL EXCHANGE OF INFORMATION - REPORTS TO INTERNATIONAL BODY

LEGALITY
SN Includes discussion of the legality of a verification system

*LITERATURE SURVEY
RT International exchange of information
Records monitoring

LITERATURE SURVEY - BUDGETARY ANALYSIS

LITERATURE SURVEY - SAMPLING
UF Sampling
RT On-site inspection - sampling
Records monitoring - sampling
Remote sensors - sampling
Short-range sensors - sampling

*MILITARY BUDGETS

Military movements or manoeuvres
Use CONVENTIONAL WEAPONS subdivided by aircraft, ground forces or ships, as appropriate.

Mobile missiles
Use NUCLEAR WEAPONS - CRUISE MISSILES
- MOBILE BALLISTIC MISSILES

Mutual force reductions
Use REGIONAL ARMS CONTROL

*NATIONAL SELF-SUPERVISION

National technical means
Use REMOTE SENSORS

New weapons of mass destruction
Use OTHER WEAPONS OF MASS DESTRUCTION

*NON-PHYSICAL/PSYCHOLOGICAL INSPECTION

Nuclear neutron weapons
Use NUCLEAR WEAPONS - RESEARCH AND DEVELOPMENT

*NUCLEAR WEAPONS

Nuclear weapons - ALBMs
Use NUCLEAR WEAPONS - BALLISTIC MISSILES

Nuclear weapons - ALCMs
Use NUCLEAR WEAPONS - CRUISE MISSILES

*NUCLEAR WEAPONS - ANTI-BALLISTIC MISSILE SYSTEMS

*NUCLEAR WEAPONS - BALLISTIC MISSILES
UF Nuclear weapons - ALBMs
- FOBS
- ICBMs
- SLBMs
- SLBM submarines

*NUCLEAR WEAPONS - COMPREHENSIVE TEST BAN

*NUCLEAR WEAPONS - CRUISE MISSILES
UF Nuclear weapons - ALCMs
- GLCMs
- SLCMs

Nuclear weapons - destruction of delivery vehicles
Use NUCLEAR WEAPONS subdivided by appropriate type of delivery system(s), e.g. NUCLEAR WEAPONS - BALLISTIC MISSILES

Nuclear weapons - destruction of warhead stocks
Use NUCLEAR WEAPONS - FISSIONABLE MATERIALS "CUTOFF"

*NUCLEAR WEAPONS - FISSIONABLE MATERIAL "CUTOFF"
SN Includes the production, stockpiling and destruction of nuclear warheads
UF Nuclear weapons - destruction of warhead stocks
- warhead stockpiling

Nuclear weapons - FOBs
Use NUCLEAR WEAPONS - BALLISTIC MISSILES

Nuclear weapons - GLCMs
Use NUCLEAR WEAPONS - CRUISE MISSILES

Nuclear weapons - ICBMs
Use NUCLEAR WEAPONS - BALLISTIC MISSILES

*NUCLEAR WEAPONS - MANNED AIRCRAFT

Nuclear weapons - MARVs
Use NUCLEAR WEAPONS - REENTRY VEHICLES

Nuclear weapons - MIRVs
Use NUCLEAR WEAPONS - REENTRY VEHICLES

*NUCLEAR WEAPONS - MISSILE TESTS

*NUCLEAR WEAPONS - MOBILE BALLISTIC MISSILES

Nuclear weapons - MRVs
Use NUCLEAR WEAPONS - REENTRY VEHICLES

Nuclear weapons - non-proliferation
Use NUCLEAR WEAPONS - PROLIFERATION

Nuclear weapons - numerical limitations on delivery vehicles
Use NUCLEAR WEAPONS subdivided by appropriate type of delivery system(s).
e.g. NUCLEAR WEAPONS - BALLISTIC MISSILES

*NUCLEAR WEAPONS - PARTIAL TEST BAN

*NUCLEAR WEAPONS - PEACEFUL NUCLEAR EXPLOSIONS

Nuclear weapons - production of delivery vehicles
Use NUCLEAR WEAPONS subdivided by appropriate type of delivery system(s)
e.g. NUCLEAR WEAPONS - BALLISTIC MISSILES

*NUCLEAR WEAPONS - PROLIFERATION
UF Nuclear weapons - non-proliferation

*NUCLEAR WEAPONS - REENTRY VEHICLES
UF Nuclear weapons - MARVs
- MIRVs
- MRVs

*NUCLEAR WEAPONS - RESEARCH AND DEVELOPMENT
UF Nuclear neutron weapons

Nuclear weapons - SLBMs
Use NUCLEAR WEAPONS - BALLISTIC MISSILES

Nuclear weapons - SLBM submarines
Use NUCLEAR WEAPONS - BALLISTIC MISSILES

Nuclear weapons - SLCMs
Use NUCLEAR WEAPONS - CRUISE MISSILES

Nuclear weapons - warhead stockpiling
Use NUCLEAR WEAPONS - FISSIONABLE MATERIALS "CUTOFF"

ON-SITE INSPECTION
RT Short-range sensors

*ON-SITE INSPECTION - CONTROL POSTS

*ON-SITE INSPECTION - GENERAL

*ON-SITE INSPECTION - IAEA SAFEGUARDS

ON-SITE INSPECTION - NON-OBLIGATORY
SN Includes "verification by challenge" and inspection by invitation

*ON-SITE INSPECTION - OBLIGATORY
SN Includes systems where the requirement to allow on-site inspection of some form is legally binding

*ON-SITE INSPECTION - PROGRESSIVE/ZONAL

ON-SITE INSPECTION - SAMPLING
UF Sampling
RT Literature survey - sampling
Records monitoring - sampling
Remote sensors - sampling
Short-range sensors - sampling

*ON-SITE INSPECTION - SELECTIVE

*OTHER WEAPONS OF MASS DESTRUCTION
UF New weapons of mass destruction

OTHER WEAPONS OF MASS DESTRUCTION - ENVIRONMENTAL MODIFICATION
UF Environmental modification weapons

OTHER WEAPONS OF MASS DESTRUCTION - RADIOLOGICAL
UF Radiological weapons

Peacekeeping forces
Use ON-SITE INSPECTION - GENERAL

Peace observation forces
Use ON-SITE INSPECTION - GENERAL

PERSONNEL
SN Includes explicit substantive discussions of personnel requirements of a verification system

Radiological weapons
Use OTHER WEAPONS OF MASS DESTRUCTION - RADIOLOGICAL

RECORDS MONITORING
RT International exchange of information
Literature survey

RECORDS MONITORING - ECONOMIC

RECORDS MONITORING - PERSONNEL

RECORDS MONITORING - PLANT

RECORDS MONITORING - SAMPLING
UF Sampling
RT Literature survey - sampling
On-site inspection - sampling
Remote sensors - sampling
Short-range sensors - sampling

*REGIONAL ARMS CONTROL
SN (a) Includes regions defined geographically (e.g. Europe) or environmentally (e.g. outer space).
(b) Subdivided by name of geographic region or by type of environment, as appropriate
UF Anti-satellite weapons systems
Mutual force reductions

REGIONAL ARMS CONTROL - DEMILITARIZATION
SN Includes partial or complete elimination of arms and/or forces in a region, as well as disengagement or withdrawal of forces.

REGIONAL ARMS CONTROL - NUCLEAR WEAPONS FREE ZONES

*REMOTE SENSORS
UF Intelligence methods
National technical means
RT Seismic sensors

REMOTE SENSORS - AERIAL

Remote sensors - Air sampling at borders
Use REMOTE SENSORS - SAMPLING

REMOTE SENSORS - ELINT

REMOTE SENSORS - GROUND BASED

REMOTE SENSORS - RADAR

REMOTE SENSORS - SAMPLING
UF Remote sensors - air sampling at borders
Sampling
RT Literature Survey - sampling
On-site inspection - sampling
Records monitoring - sampling
Short-range sensors - sampling

REMOTE SENSORS - SATELLITE

REMOTE SENSORS - SHIPBOARD

*REVIEW CONFERENCE

Short-range sensors - seismic sensors
Use SHORT-RANGE SENSORS - MONITORING DEVICES

Short-range sensors - toxicological analysis
Use SHORT-RANGE SENSORS - SAMPLING

Strategic Arms Limitation Talks
Use NUCLEAR WEAPONS subdivided by appropriate type of delivery system, e.g. NUCLEAR WEAPONS - BALLISTIC MISSILES

Tactical Nuclear Weapons
Use NUCLEAR WEAPONS subdivided by appropriate type of delivery system, e.g. NUCLEAR WEAPONS - BALLISTIC MISSILES

CHAPTER A

GENERAL ON-SITE INSPECTION*

General on-site inspection involves unrestricted access to the physical objects and related facilities which are subject to control under the terms of specific agreements. The relevant agreements could conceivably range in scope from general and complete disarmament to control of specific weapons systems. Unrestricted or general access inspection is to be contrasted with selective or progressive on-site inspection which are discussed in later chapters.

Like other verification methods, the purpose of general on-site inspection is to preclude the possibility of clandestine violations of an agreement. The degree of assurance thought to be attainable using this method varies. Some proposals consider general inspection to be capable of uncovering all possible violations, while others hold that general inspection only increases the likelihood of discovery and thereby improves the deterrent value of the verification system.

Several criticisms of general on-site inspection have appeared relating to the high cost, problems in recruiting qualified manpower and difficulties in defining the nature of the inspectorate. States have also differed in their views regarding the extent of access to be given inspectors. One country may take the view that it should be allowed to specify which of its own military sites should be open to unrestricted inspection, another the view that all participants have the right to inspect any site in any country which they suspect may contain some of the weapons or materials subject to the control agreement. These ambiguities tend to be less significant when an agreement deals with the control of all arms so that all military sites should be open. Consequently, this type of proposal has usually been applied to prospective agreements for general and complete disarmament (GCD), or for regional arms control where all significant sites in a specified region are open to inspection.

Examination of the set of proposals suggests that "unrestricted access" is seldom interpreted literally and that considerable attention needs to be paid to framing the definition to avoid breaches of security on the one hand or evasion of commitments on the other. Proposal A12(T75) seems to be a good example of the kind of detail that may be needed for the conclusion of a successful agreement, and incidentally shows that the cost of this type of verification is likely to be substantial.

Peacekeeping Operations

Peacekeeping and peace observation forces perform many functions such as surveillance and reporting which can be accurately described as verification of regional arms control undertakings. This is true

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* The term "inspection", as used in this chapter and the three following ones, refers to inspections conducted by adversary or neutral personnel, not to self-inspection which is dealt with in chapter L.

particularly regarding the monitoring by such forces of demilitarized zones and disengagement agreements which **involves general on-site inspection** as well as other verification techniques. In addition, many aspects of the organizing and performance of peacekeeping operations may give insight into similar problems faced by on-site inspection systems in a variety of arms control contexts. Finally, past experience with another kind of peace observation - international fact-finding commission established to investigate specific international disputes - may have considerable relevance in the area of verification of arms control agreements especially in relation to the implementation of some types of complaints procedures.

It must, however, be pointed out that there are several differences between peacekeeping generally and arms control verification. For example, peacekeeping operations are frequently set up on relatively short notice when military conflict is imminent or actually occurring. This is unlikely to be the case for most arms control verification operations. Furthermore, peacekeeping often includes activities beyond the monitoring role, such as mediation and the use of force in self-defence. Nevertheless, despite these differences many characteristics of peacekeeping operations are relevant both directly and by analogy to arms control verification. Consequently, several discussions of peacekeeping and peace observation forces have been included in this chapter.

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Arms Control Objective	Number of Proposal Abstracts
Nuclear weapons	2
Conventional weapons	2
Regional arms control	17
General and complete disarmament	2
Any arms control agreement	2
	25

PROPOSAL ABSTRACT A1(A77)

1. Arms Control Problem:
   Nuclear weapons

2. Verification Type:
   a) On-site inspection - general
   b) International control organization

3. Source:
   Rathjens G. "The Conditions Necessary for Complete Disarmament - The Case for Partial Nuclear Disarmament". In A New Design for Nuclear Disarmament: Pugwash Symposium, Kyoto, Japan, pp. 132-4. Edited by W. Epstein and T. Toyoda. London: Pugwash, 1977.

4. Summary:

The author contends that to prevent the acquisition of nuclear weapons in a nuclear disarmed world several dramatic changes in the international system would be needed, tantamount to something like world government. All countries would have to accept intrusive inspection to preclude weapons manufacture which would include frequent inspection of very large numbers of industrial facilities and laboratories including the right to search virtually anywhere. Unrestricted access would be particularly necessary in the case of states which previously had nuclear weapons. Practically speaking, what is required is an international authority with rights of inspection that will be far more intrusive than has so far been accepted by national states.

To ensure timely access to any suspected installation where nuclear weapons might be stored or produced, the international authority must have sufficient forces to overcome resistance rapidly (ie. stronger than residual police or military forces in any state).

Additional measures might include establishment of rewards and rights of asylum for persons disclosing proscribed activities, monitoring training programs of national police or armies, and facilitating frequent exchanges of different nationals in laboratories, industrial establishments and national police and military staffs.

PROPOSAL ABSTRACT A2(A78)

1. Arms Control Problem:
    a) Nuclear weapons - ballistic missiles
       - cruise missiles
       - manned aircraft
    b) Regional arms control - Europe
       - nuclear weapons free zone

2. Verification Type:
    a) On-site inspection - general
    b) Remote sensors

3. Source:
    Coffey, J. "Arms Control and Tactical Nuclear Forces and European Security". In Stockholm International Peace Research Institute. Tactical Nuclear Weapons: European Perspectives, pp. 175-203. London: Taylor and Francis, 1978.

4. Summary:

Coffey reviews several approaches to controlling tactical nuclear forces in Europe. Control of tactical nuclear delivery vehicles in Europe with some minor exceptions is verifiable; their numbers are fairly well known, they are difficult to hide and the intelligence networks of both NATO and the Warsaw Pact are probably sufficiently good to ensure against gross violations. Verifying the removal of tactical nuclear warheads from the area would, however, be more difficult. While it would be relatively easy to verify that they had been transferred out of the area, it would be harder to check on remaining stocks without some intrusive inspection and it would be virtually impossible to preclude weapons from being moved back in again. Similarly, verifying compliance with the creation of a nuclear weapons free zone would require knowledge of procedures for supplying nuclear warheads and some intrusive inspection without advance notice.

Controlling the introduction of new weapons into the area would be hard. It would be almost impossible to preclude gradual alterations in weapons systems. While it is possible to inhibit development of new weapons when these reach the test stage by restricting testing or numbers that can be deployed, it is hard to cover all the kinds of systems that can play a nuclear role. Once weapons are introduced into inventory it is possible to readily identify new types but the multiple roles of some systems means that it is difficult to get agreement on their restriction. Such restrictions on new weapons because of the verification difficulties should be limited to important, relatively scarce and highly visible weapons. Checks on features such as the yield or degree of radioactivity of nuclear warheads would be virtually impossible.

PROPOSAL ABSTRACT A3(G70)

1. Arms Control Problem:
   a) Conventional weapons - ground forces
                           - aircraft
   b) Regional arms control - Europe

2. Verification Type:
   a) On-site inspection - general
                         - selective
                         - control posts
   b) Remote sensors - aerial
   c) Short-range sensors - monitoring devices

3. Source:
   United States. Arms Control and Disarmament Agency. Field Operations Division. Weapons Evaluation and Control Bureau. Summary Report Field Test F-15 Exercise First Look: Inspection and Observation of Retained Levels of Ground and General Purpose Air Forces in a Specified Area (UK). February 1970.
   See also: - Final Report Field Test FT-15 Exercise First Look, volumes I, II and III. February 1970.
   - Final Report Field Test FT-15 Exercise First Look: Procedures Manual. February 1970.

4. Summary:

Despite technological advances since the time when this study was conducted, it remains pertinent to modern arms control inspection schemes intended to monitor conventional forces, in terms of both its findings and conclusions.

Field Test FT-15 was conducted over thirteen weeks in the Spring of 1968 in a 2,000 square mile area of southern England. A table of test exercises which led up to FT-15 is provided in Table 1 of this abstract. FT-15 involved personnel from the armed forces of the UK and the USA. The aim of the test was to evaluate performance of different inspection organizations operating in a foreign environment against foreign military forces. Several configurations were tested to obtain information regarding a number of specific objectives. Variables included:

1) number of inspection teams,
2) degree of access to installations,
3) availability to inspectors of aerial reconnaissance data,
4) availability to inspectors of data from unattended ground sensors,
5) use of aerial reconnaissance data alone,
6) use of unattended ground sensor data alone,
7) use of aerial reconnaissance data and unattended ground sensor data in combination,
8) use of declarations by host,
9) problems with data handling procedures,

10) detection of evasion,
11) degree of intrusiveness, and
12) operational problems.

Test design:

Twenty ground inspection team configurations were tested each involving different combinations of the following variables: number of teams in the inspection group, access to installations, use of aerial surveillance data and use of unattended ground sensor data.

Three special inspection techniques were tested. One used aerial reconnaissance data alone, one used ground sensor data alone, and the third used a combination of both.

The basic assignment for each inspection group was to determine the force level (order of battle) of the army and air force units in the inspection area and to update their findings whenever changes occurred. The performance of the groups was evaluated by the average percentage errors made in estimating various categories of military strength (eg. number of personnel, number of different kinds of military equipment, identifying units by name and specifying locations). This error rate was based on the absolute difference between estimates by inspection groups and the actual number of targets present. Both underestimates and overestimates were counted as errors.

Results:

a) The overall performance of all inspection groups had errors in excess of 20% for all tasks. This was true even for the high access groups though they did better than the low access ones.
b) There was a wide variation in the performance of different inspections groups in the accuracy of their estimates.
c) The performance of the inspection groups with few teams was particularly poor under low access conditions. Under high access their performance was not much different from groups with more teams, indicating that the effect of the number of teams was less important than degree of access permitted.
d) Ground inspection groups did not make much use of aerial reconnaissance data because they were not trained to interpret it.
e) Aerial reconnaissance performed well for some types of targets (eg. vehicles) but poorly in other contexts (eg. artillery). Aerial surveillance alone and ground inspections alone performed best against different types of targets suggesting that an effective inspection system would include a combination of both these techniques.
f) The ground sensor system was not operational for sufficient time to produce significant results. There were indications, however, that the contribution of such sensors would be

limited to monitoring military 'choke' points not used by civilians.

g) Leadership quality tended to have an important impact on inspection group performance.

h) Small inspection groups could not maintain as much inspection per inspector as larger groups because of greater travel requirements.

i) Since no overall order of battle assessment procedures were prescribed for the inspection groups, each one developed its own which resulted in major differences in performance. On the basis of work done by intelligence experts, it may be possible to codify rules more comprehensively and in more detail for use by ground inspection teams.

j) Inspection groups made little use of declarations made by the host because they did not believe them. For declarations to be really useful to inspection groups they must be very detailed and inspection procedures must be explicitly designed around their use.

k) Only minor evasions were attempted none of which provided analyzable results. To determine the detection capability of the inspection groups, large scale evasions over long periods would need to be conducted. These would be costly and interfere with normal training. In an actual arms control situation such evasions would be even more costly and risky.

l) Questionnaires submitted to most unit officers on the intrusiveness of the inspectors indicated that they did not find the inspectors very intrusive. However, even in this friendly environment there were some negative reactions suggesting that inspectors in a real arms control situation would have to be very discreet.

Conclusions:

1. A ground inspection system alone of the size of existing Military Liason Missions (which would permit one inspector per thousand miles with access only to base perimeter), cannot be expected to verify an arms limitation relating to general purpose ground and air forces where errors of over 20% are not acceptable.
2. Aerial reconnaissance by itself without assistance from other information sources and with similar coverage as provided in FT-15 cannot be expected to suffice within the same limits.
3. Unattended sensors can be expected to make contributions only to very special tasks related to general purpose air and ground force verification.
4. Because different methods used in observing and estimating target forces were more accurate on different targets, a system with a well integrated combination of aerial surveillance

TABLE I
TESTS PRIOR TO FT-15
(source: Final Report Field Tests FT-15 Exercise First Look, vol. I, pp. 1-2)

NAME	DATE	PURPOSE	RESULTS
1. CG-3 'Resident Inspection of an Army Installation' CG-3A 'Aerial Photographic Surveillance of an Army Installation	1964	- to determine the verification capabilities of a small resident inspection team operating on a military installation - to acquire preliminary information on the applicability of aerial photographic reconnaissance to on-site inspection of a military installation	- resident teams could easily maintain an accurate inventory of 3400 vehicles at the installation and simple evasion tactics were easily detected
2. CG-12 'Military Activity Monitoring'	1964	- to test inspection methods and performance of observation post teams stationed at road and rail junctions, airfields and along geographic or political border areas in monitoring movement of military forces - aerial image reconnaissance over routes of movement also tested	- ground inspection teams, air observation units, and **aerial** image reconnaissance were all able to detect and identify a large percentage of the military movements passing through monitored road and rail junctions
3. CG-13 'Inspection of Retained Levels of General Purpose Air Forces'	1964	- to test various inspection techniques for checking compliance with a postulated agreement limiting personnel, combat aircraft and support facilities of general purpose air forces	- two man inspection teams were able to inventory aircraft better than one man teams - free access improved inventory accuracy for tactical aircraft
4. FT-4 'Inspection of Retained Levels of Ground Forces'	1968	- to test techniques of intermittent inspection for verifying compliance with limitations on deployment of ground forces	- larger teams (five-man) were more accurate than smaller teams - evasive concealment of small mortars and recoilless rifles was very successful

and ground inspection may provide performance with a 10% accuracy for general purpose forces limitations.

As a result of FT-15 a Procedures Manual was produced describing the basis for an arms control inspection system in a developed area such as Central Europe. It assumes that an adequate road network exists for inspector movement and that most military units are designated. There are three sections to the Manual:

1) arms control agreement aspects,
2) setting up of the inspectorate and requisite logistic support, and
3) command and control of the inspectorate.

Annexes include sample data reporting forms and data displays to aid inspectorate operations.

PROPOSAL ABSTRACT A4(A61)

1. Arms Control Problem:
   Conventional weapons - ground forces
2. Verification Type:
   a) On-site inspection - sampling
   b) International exchange of information
3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In Arms Control: Issues for the Public, pp. 134-135. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.
4. Summary:
   This proposal begins by assuming an initial mandatory disclosure of numbers and locations of all conventional weapons and troops at the time the agreement becomes effective. The use of sampling techniques applied to on-site inspection, as well as intelligence sources, should permit good assurance of the veracity of the disclosures. As forces are de-mobilized and their weapons destroyed inspection teams would carry out surveillance operations to ensure that levels were not augmented. Weapons destruction would be carried out under supervision by the inspectorate. Factories engaged in heavy arms production would also be monitored.

15(A62)

PROPOSAL ABSTRACT A5(A62)

1. Arms Control Problem:
   Regional arms control

2. Verification Type:
   On-site inspection - general

3. Source:
   Schelling, T.C. "A Special Surveillance Force". In Preventing World War III: Some Proposals, pp. 87-105. Edited by Quincy Wright, William M. Evan and Morton Deutsch. New York: Simon and Schuster, 1962.

4. Summary:

This paper's proposal is founded on the expectation that in certain circumstances the US and USSR may be confronted by a situation where they must rapidly agree on some disarmament measures and will need a group of observers on short notice to verify the agreement. Such a situation of "crash disarmament" could arise if the two countries found themselves on the brink of war. To meet such a situation, Schelling suggests the creation of a standing special surveillance force which would be in existence and ready to monitor compliance with any agreement. There would be two forces, each made up of the nationals of one side and located on the territory of the other. Both would be characterized by readiness, speed, reliability, self-sufficiency, versatility and ability to improvise.

It would be important that each force have quick and reliable communications with their own governments and that they be prepared to move sizable distances rapidly. They would initially be located at dispersed stategic points to allow quick travel times to places they might be needed. Freedom of movement would also be essential.

Each force would also need extensive practice in operating their equipment, coordinating with their hosts and in overcoming obstacles in order to be ready to undertake their verification duties in a crisis.

PROPOSAL ABSTRACT A6(G63)

1. Arms Control Problem:
   Regional arms control - Europe

2. Verification Type:
   a) On-site inspection - general
   - control posts
   b) Records monitoring - economic
   c) Remote sensors - aerial
   - satellite

3. Source:
   Wainhouse, D.W., ed. Arms Control Agreements: Designs for Verification and Organization. Baltimore: The Johns Hopkins Press, 1968.

4. Summary:

This proposal, originally presented as the Gomulka Plan of 1963, deals with a freeze on the quantity of nuclear weapons stationed in a central European zone to include Poland, Czechoslovakia, West Germany and East Germany. A commitment to refrain from transferring nuclear weapons (but not delivery vehicles) to this area would be undertaken. Furthermore, parties would be obligated not to produce nuclear weapons in the zone and not to introduce nuclear weapons into the zone.

Verification and control would be exercised by mixed commissions of representatives from the Warsaw Pact and NATO on a parity basis. These commissions could be enlarged to include representatives from other states. Periodic meetings of the representatives of the nuclear powers would be held in order to exchange information and reports in regard to obligations undertaken in the freeze on nuclear weapons.

Specifically, there would be a Western Verification Organization (WVO) and an Eastern Verification Organization (EVO). Each would have an administrator, a Headquarters Unit and a number of control units in East Germany four in Poland and three in Czechoslovakia, while the EVO would maintain four control units in West Germany. Control units would report directly to their respective Verification Organizations which would in turn report to the next higher organization established by parties to the agreement.

The process of inspection itself would be carried out both by mobile teams and by stationary control posts. The exchange of military missions, governmental budget and economic record verification and verification by aircraft and satellites could supplement the ground inspection.

PROPOSAL ABSTRACT A7(A71)

1. Arms Control Problem:
   Regional arms control - demilitarization

2. Verification Type:
   On-site inspection - general

3. Source:
   Boyd, James M. United Nations Peace-keeping Operations: A Military and Political Appraisal. New York: Praeger, 1971.

4. Summary:
   This book focusses on three UN peace-keeping operations: UNEF (1956), ONUC (1960) and UNICYP (1964). Of main interest in the context of arms control verification is the book's discussion of the problems - legal, political and administrative - surrounding the creation, composition and operation of these peacekeeping forces. Several recommendations by the author are included. Particularly relevant chapters are:
   7. Force Composition and Organization,
   8. Command and Control, and
   10. Military Readiness.

PROPOSAL ABSTRACT A8(A78)

1. Arms Control Problem:
   Regional arms control - demilitarization

2. Verification Type:
   On-site inspection - general
   - control posts

3. Source:
   International Peace Academy. Peacekeeper's Handbook. New York: International Peace Academy, 1978.

4. Summary:
   The Handbook is intended to serve both as a teaching aid and as an operational notebook for members of UN peackeeping operations. It covers several areas of potential interest in regard to the establishment of on-site inspection schemes for arms control verification. There is coverage of such general practical questions as administrative organization, logistics support, communications systems, and operational procedures for relatively large groups of observers. There are also sections which deal with observation techniques (including how to set up observation

posts), surveillance reporting (including supervision of armament control agreements, establishment of buffer or demilitarized zones, surveillance of military deployment limitations, and supervision of military withdrawals or disengagement), patrolling and reporting, and information gathering. Also included in the Handbook are practical examples of floorplans for observation posts, organization charts and report forms.

PROPOSAL ABSTRACT A9(A74)

1. Arms Control Problem:
   Regional arms control - demilitarization
2. Verification Type:
   On-site inspection - general
3. Source:
   Rikhye, Indar Jit, *et al*. *The Thin Blue Line: International Peacekeeping and Its Future*. New Haven, Conn.: Yale University Press, 1974.
4. Summary:
   This work provides a description and some evaluation of several peacekeeping and observer missions. Case studies include chapters on UNEF II, UN Observer and Supervisory Missions, and Indochina observer activities.

PROPOSAL ABSTRACT A10(A66)

1. Arms Control Problem:
   Regional arms control - demilitarization

2. Verification Type:
   On-site inspection - general

3. Source:
   Wainhouse, David W. International Peace Observation: A History and Forecast. Baltimore: Johns Hopkins Press, 1966. See also: International Peacekeeping at the Crossroads: National Support - Experience and Prospects. Baltimore: John Hopkins Press, 1973.

4. Summary:

International Peace Observation is an extensive and detailed work which examines more than seventy cases since World War I where "international peace observation" has been employed. Peace observation is defined as a method whereby the organized international community initiates a third party intervention as early as possible in a threatening situation with a view to permitting calmer judgements to allay the potential or actual conflict.

The book covers cases involving the League of Nations, several Inter-American organizations, the UN and other multilateral arrangements. Each case study includes a brief description of the history of the dispute, the peace observation arrangements that were created to deal with it and an evaluation of these arrangements. In the final section of the book the author lays out his general conclusions together with suggestions regarding future peace observation activities. Included here is a detailed proposal for the organization and equiping of a permament UN peace observation corps, a body which conceivably could find use in an arms control verification situation. Of interest in the final section of the book are also chapters dealing with:

- Authority and Terms of Reference,
- Peace Observation and Cooperation of the Parties,
- Chief Tasks of Peace Observation,
- Organization and Support of Peace Observation Missions, and
- Termination of Peace Observation.

International Peacekeeping at the Crossroads covers several cases since World War II. Details about organization, personnel and logistics are given for each case. The conclusions and recommendations, however, are mainly intended for US policy makers.

PROPOSAL ABSTRACT A11(T59)

1. Arms Control Problem:
   Regional arms control - demilitarization
   - Antarctica

2. Verification Type:
   a) On-site inspection - general (Article 7)
   - obligatory
   b) Remote sensors - aerial (Article 7(4))
   c) International exchange of information (Article 7 (5))
   d) Complaints procedure - consultation and cooperation (Article 11 (1))
   - referral to International Court of Justice (Article 11 (2))
   e) Review conference - (Article 9 (1))

3. Source:
   The Antarctic Treaty
   Signed: 1 December, 1959.
   Entered into force: 23 June, 1961.
   Number of parties as of 31 December, 1979: 20.

4. Summary:
   The Treaty's system of control is based on the use of inspectors (Article 7). Inspectors are nationals of the states parties which designate them and they remain under the exclusive control of their national government no matter where they are in Antarctica (Article 8), in order to prevent disputes over jurisdictional claims. These observers have full access to all installations, ships and aircraft at all times. Aerial surveillance is also permitted. In addition, each party is required to inform the others of all expeditions it launches to Antarctica, stations it occupies there and military personnel or equipment which it introduces to the continent (Article 7 (5)). This information can be verified by inspection.

A12(T75)

PROPOSAL ABSTRACT A12(T75)

1. Arms Control Problem:
   a) Regional arms control - demilitarization
   - Middle East
   b) Conventional weapons - ground forces

2. Verification Type:
   a) On-site inspection - general
   - control posts
   - obligatory
   b) Short-range sensors - monitoring devices
   c) Remote sensors - aerial
   d) Complaints procedure - consultative commission

3. Source:
   Agreement Between Egypt and Israel, and Annex. (Sinai Disengagement Agreement).
   Signed: September 1, 1975.
   Early Warning System Proposal by the United States of America. September 1, 1975.
   See also: Kolcum, E.H. "New Sensors Evaluated in Sinai Buffer". Aviation Week and Space Technology (23 August 1976): 40-42.
   United States. Sinai Support Mission. Report to the Congress. Washington, D.C.: 13 April 1978.

4. Summary:

The agreement provides for disengaging Egyptian and Israeli forces in the Sinai. It establishes two zones in which forces of each side must be limited. These two zones are placed on either side of a buffer zone where no military personnel of the two sides are to be stationed (save for the exception discussed below). The United Nations Emergency Force (UNEF) is to occupy this buffer zone. Another zone under UNEF control is established in the South.

The Annex of the agreement defines some of the verification provisions. (This Annex is a statement of agreed principles to serve as a basis for a Protocol which was subsequently negotiated.) As agreed the UNEF has complete control of the buffer zone. In the Southern demilitarized zone UNEF has freedom of movement and checkpoints so as to ensure that no military forces are present. Both these functions might be described as a form of general on-site inspection on the part of UNEF.

In the two restricted military force zones UNEF conducts on-site inspections to ensure maintenance of the agreed force limitations. This again is a type of general on-site inspection.

An additional verification method employed is aerial surveillance. Overflights were originally conducted by the USA once every 7-10 days or on request. Results of these reconnaissance flights were provided to both parties and to UNEF. Subsequently, it was agreed that Egypt and Israel could make seven reconnaissance flights over the area each week provided no more than two aircraft are used at a time and flights are not less than an altitude of 15,000 ft. They must fly along the buffer zone centerline and make no abrupt turns while over the zone.

Finally, the USA proposed and it was eventually agreed that two "surveillance" stations and three "watch" stations be established as part of an early warning system. The two "surveillance" stations, one Egyptian and one Israeli are established in the buffer zone near the strategic Giddi pass. They perform the functions of visual and electronic surveillance. Each station is limited to 250 personnel armed only with light defensive weapons.

The three "watch" stations were established by the USA on the Mitla and Giddi passes. American civilian personnel operate these installations which also include three unmanned electronic sensor fields. The stations report any unauthorized activity by either Egypt or Israel in the two "surveillance" stations and any unauthorized movement of troops into the passes or preparation for such movement.

A complaints procedure is established under Article 6 of the agreement. It is in the form of a joint commission of the parties under the aegis of the Chief Coordinator of the UNEF.

The following sensor systems, some of which were used to monitor the de-militarized zone between North and South Vietnam, were employed to monitor the Sinai Disengagement Agreement.* These include:

> an electronic fence and a passive infrared confirming scanner. The electronic fence is called SSCS for strain sensitive cable sensor. It is basically a coaxial cable implanted in the sand along both sides of the roadway. When anything passes through, it transmits a signal....
>
> The scanner is called Pires. It displays an infrared

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* This discussion is taken from: E.H., Kolcum, "New Sensors Evaluated in Sinai Buffer". Aviation Week & Space Technology (23 August 1976): 40-42.

picture that tells a trained operator what type of incursion is taking place - whether it is a large force, a single person, tank or jeep. The operator also can determine direction and speed.

Much of the equipment used in Vietnam now in place here has undergone refinement and modification. It includes: Minisid 3, a seismic intrusion detector that senses earth vibrations. Battery-operated, it is implanted under 6 in. of sand at random distances along entrances to the passes. It can detect a vehicle 1,650 ft. away, and a person 150 ft. distant. Circuitry in Minisid 3 will self-destruct unless a combination code is used to open it. Batteries last about a year.

AAU, which means acoustic add-on unit....is activated when Minisid senses earth vibrations and it transmits sounds from the intrusion to the watch station.

Dirid, for directional infrared entrusion detector.... is a passive optical device with two fields of view along the pass entrances. It is used to complement Minisid 3's sensors. When an intrusion occurs, the returned signal tells the operator what sensor was excited and Dirid can be aimed at that point.

TVS-4, basically a pair of binoculars with a large aperture....enables visible verification of eruptions from electronic sensors.

When a sensor is excited, it returns a signal to the watch station where a time history of the movement is recorded on metalized chart paper. As soon as an intrusion is verified, a VHF radio message, backed by teletypewriter, is sent to a State Department liaison officer at base camp. He immediately communicates that there is an intrusion, and the Sinai Field Mission analysis of it, to the United Nations in Ismailia, Egypt, the Egyptian Ministry of War in Cairo, Israeli Defence Force in Tel Aviv and to the single Israeli and Egyptian surveillance sites just inside the buffer zone....The base camp also has a secure communications link - an HF single sideband radio teletypewriter that ties into the U.S. government communications network.

An alternate means and procedure for detection is being developed by the United States Sinai Support Mission (SSM), according to a recent report.* The system currently used has been described in the previous paragraph. Under the alternate system:

...signals from the unmanned sensor fields are relayed directly to the operations center at the Sinai Field Mission Headquarters and all sensor activations are instantly displayed on a scaled map of the early warning area. As sensor activations light up small bulbs on the map, the Operations Officer can instantly see the location of an intrusion, and by observing the number of sensors in a line of sensors

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* United States Sinai Support Mission. Report to the Congress. 13 April 1978, pp. 10-14.

perpendicular to the road that are activated, he can determine the nature of the object involved. The heavier the object the more sensors are activated and the more lights flash. An intruder can then be tracked through the early warning area by observing the sequence of lights on the map.... This system should improve the timeliness, accuracy, and completeness of the early warning system detection process. (pp. 10-11)

In addition, two other developments are of interest. First, the SSM is adding a new remotely-controlled day and night camera system to the sensors already deployed. This system will detect an object before it enters the existing sensor fields and will therefore reduce the time necessary to identify an intruder.

The second development arises from the fact that the ability of monitoring personnel to identify activity in the sensor fields deteriorates appreciably under conditions of poor visibility especially dust and ground fog. In an attempt to overcome this problem, the SSM has borrowed two thermal imaging devices from the US Army. These devices, which are similar to the forward-looking infrared system (FLIR), can detect the infrared energy emitted by objects. It is expected that dust and fog will cause less interference for these devices than for visible light sensors.

The number of personnel presently working in the Sinai Field Mission is 160. Cost of the watch stations and base camp was approximately $25 million. The budget for the 1978 fiscal year is $12.2 million and the estimated budget for FY 1979 is $11.7 million.

The Sinai Support Mission will be terminated upon completion of the withdrawal of Israeli forces from the Sinai, pursuant to the Egypt-Israel Peace Treaty of March 1979.*

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* See abstract A14(T79).

PROPOSAL ABSTRACT A13(A78)

1. Arms Control Problem:
   Regional arms control - demilitarization
   - Middle East

2. Verification Type:
   a) On-site inspection - general
   b) Short-range sensors - monitoring devices
   c) Remote sensors - aerial
   d) Complaints procedure - consultative commission

3. Source:
   Shalev, Aryeh, Brig. Gen. (Res.). Security Arrangements in Sinai Within the Framework of a Peace Treaty with Egypt. Tel Aviv: Center for Strategic Studies, Tel Aviv University, October 1978. CSS Papers, no. 3.

4. Summary:

   This paper outlines proposals for the security arrangements in the Sinai to be included in an Egypt/Israel peace agreement. One of the aspects discussed is supervision and early warning. In general these include:
   1) an international force in specific zones in the Sinai,
   2) early warning stations on both sides of a demilitarized area,
   3) mechanisms of control over the demilitarized areas and areas of limited forces by UN observers,
   4) apparatus for clarifications and coordination between Egypt and Israel, and
   5) mechanisms for obtaining aerial photographs of the area.

   The paper reviews several approaches to these questions outlining their disadvantages and advantages.

PROPOSAL ABSTRACT A14(T79)

1. Arms Control Problem:
   a) Regional arms control - demilitarization
   - Middle East
   b) Conventional weapons - aircraft
   - ground forces
   - ships

2. Verification Type:
   a) On-site inspection - general
   - selective
   - control posts
   - obligatory
   b) Short-range sensors - monitoring devices
   c) Remote sensors - aerial
   d) Complaints procedure - consultative commission

3. Source:
   Treaty of Peace between the Arab Republic of Egypt and the State of Israel and Annexes.
   Signed: 26 March 1979.
   See also: - Framework for Peace in the Middle East at Camp David. 17 September 1978.

4. Summary:

The Treaty provides for the normalization of relations between Egypt and Israel and withdrawal of Israeli forces from the Sinai. It also specifies limited force zones in the Sinai area after completion of the withdrawal.

The Withdrawal:

UN forces will be used to supervise the withdrawal and they will employ their best efforts to prevent any violations. As soon as Israeli forces withdraw, UN forces will enter the evacuated areas to establish temporary buffer zones which will entail setting up checkpoints, reconnaissance patrols and observation posts. They will also perform verification functions in the limited force zones created as the withdrawal progresses (Articles 1 2 and 5 of the Appendix to Annex 1). These functions are tantamount to general on-site inspection.

A Joint Commission of the parties will be established for the duration of the withdrawal. It will supervise the implementation of the withdrawal including the resolution of any problems which arise and the provision of assistance to UN forces. The Commission will meet at least once a month or at the request of either party or the UN force commander (Article 1 (4) of Annex 1 and Article 4 of the Appendix to Annex 1).

In accordance with arrangements agreed upon by the parties and coordinated by the Joint Commission "military technical installations" will be operated at four locations in the buffer zone during the withdrawal. A third party agreed upon by Egypt and Israel will enter and conduct inspections of these installations in a random manner at least once a month. These inspections will verify the nature of the operation of the installations and compliance with agreed weapons and personnel limitations therein. The third party will immediately report to the parties any divergence from an installation's visual and electronic surveillance or communications role (Article 5 of Appendix to Annex 1). This activity by the third party can be described as a form of selective on-site inspection.

In addition to these 'technical installations' of the two parties, the US is requested to continue the operation of its Sinai Field Mission early warning station until the completion of the withdrawal, at which time it will be terminated (Article 7 of Appendix to Annex 1).

The US is also requested to continue its airborne surveillance flights in accordance with previous agreements until the completion of the Israeli withdrawal (Article 7 of Appendix to Annex 1).

Finally, during the withdrawal, Egyptian technical teams will be permitted to observe and familiarize themselves with the operation of facilities to be transfered by Israel to Egypt for a period of up to two weeks prior to transfer (Article 6 of Appendix to Annex 1).

Post-Withdrawal Security Arrangements:

Once the Israeli withdrawal has been completed, the treaty designates four permanent limited force zones* in the Sinai and in Israel. As when monitoring the withdrawal, UN forces and observers are to supervise the implementation of these zones and employ their best efforts to prevent any violations. UN forces will operate checkpoints, reconnaissance patrols and observation posts in one of these zones along the international border. They will conduct periodic verification of the implementation of the final zones at least twice a month or within 48 hours after a request by the parties. The UN forces will also insure freedom of navigation through the Strait of Tiran.

UN verification teams are to be accompanied by liaison officers of the two parties. Personnel of the UN forces will enjoy freedom of movement and other facilities necessary for the performance of their tasks and the UN will be able to make command arrangements which will best assure the exercise of its responsibilities. Egypt and Israel must agree on the nations from which the UN forces are drawn and these must exclude permanent members of the Security Council (Aricle 2 & 6, Annex 1). By Article 4 of the Treaty, UN forces will not be withdrawn without the approval of all the permanent members of the Security Council unless the parties otherwise agree.

Early warning stations of the parties can be established, but only in two zones: in zone 'A' (near the Red Sea and Suez Canal)

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* The limitations extend to naval and air operations in the Sinai area.

in the case of Egypt and in zone 'D' (along the Israeli border) in the case of Israel. Flights of reconnaissance aircraft by the parties are also limited to these same zones (Articles 5 and 3, Annex 1).

When the Joint Commission which monitors the Israeli withdrawal is terminated upon completion of the withdrawal, a liaison system between the parties will be established to provide an effective method of assessing progress in the implementation of the final zones and to resolve any problem that may arise. Unresolved matters may be referred to higher military authorities of the parties. Direct telephone links will be maintained between the liaison offices of the two parties and between them and the UN Command (Article 7, Annex).

PROPOSAL ABSTRACT A15(T73)

1. Arms Control Problem:
   Regional arms control - demilitarization
   - Indochina
2. Verification Type:
   On-site inspection - general
3. Source:
   Agreement on Ending the War and Restoring Peace in Vietnam and Protocols (Vietnam Peace Accords).
   Signed: 27 January 1973.
4. Summary:
   Responsibility for verification of the provisions of the Agreement was given, in part, to an International Commission of Control and Supervision (ICCS) which was established immediately upon signature of the Accords. Article 18 of the Agreement and the Protocol concerning the International Commission of Control and Supervision outlined the functions, powers and structure of the ICCS. Its functions included the control and supervision of the implementation of:
   1) the cease-fire in South Vietnam,
   2) the withdrawal of all foreign troops from South Vietnam,
   3) the dismantling of all foreign military bases in South Vietnam,
   4) the exchange of prisoners of war,
   5) the ban on introduction of troops into South Vietnam,
   6) the general elections in South Vietnam, and
   7) the reduction of troop levels of the two South Vietnamese parties.

   The ICCS was composed of representatives of four countries (Canada, Hungary, Indonesia and Poland) with the chairmanship of the Commission rotating among members. Operations of the ICCS were to be carried out in accordance with the "principle of consultation and unanimity". Until an international conference had been set up pursuant to the Agreement, the ICCS was to report to the parties. The Commission was intended to continue operations until the new government of South Vietnam formed after the general elections provided for in the Accords requested its termination.

The Protocol specified that the ICCS was to perform its functions "through communication with the parties and on-the-spot observation". It was to be allowed "such movement for observation as is reasonably required for the proper exercise of its functions" and its members were to be accorded diplomatic privileges and immunities. The Commission was also empowered to investigate violations at the request of any party or when the Commission had "adequate grounds" for considering there to have been a violation. If the Commission found that a violation had occurred it was to report this to the parties.

Numbers and location of the headquarters staff and the regional and other teams of the ICCS were spelled out in detail in the Protocol. The formula for financing the Commission was also stated.

Parties were obligated to cooperate and assist the ICCS in the execution of its duties. Regular and continuous liaison between the parties and the Commission was to be maintained. The Joint Military Commissions of the parties which were set up by the Agreement were also to cooperate closely with the ICCS.

In addition to the ICCS, a Four Party Joint Military Commission and a Two Party Joint Military Commission were created. The Joint Commissions were dealt with in Articles 16 and 17 of the Agreement and in a Protocol. These bodies were responsible for ensuring joint action by the parties in implementing the provisions of the Agreement. Among the duties of the Four Party Commission was "drawing up plans and fixing the modalities to carry out, coordinate, follow and inspect the implementation" of many of the same provisions to be monitored by the ICCS. It was also "to deter and detect violations". There was thus considerable overlap between the responsibilities of this body and the ICCS.

Personnel and location of the headquarters and the teams of the Four Party Commission were dealt with in detail in the Protocol as were the privileges and immunities of its personnel, its financing, and the responsibilities of the parties for providing assistance. This Commission was also to operate on the basis of unanimity. Disagreements were to be referred to the ICCS.

PROPOSAL ABSTRACT A16(G69)

1. Arms Control Problem:
   Regional arms control - demilitarization
   - sea bed

2. Verification Type:
   On-site inspection - general

3. Source:
   Union of Soviet Socialist Republics. "Draft treaty on prohibition of the use for military purposes of the sea bed and the ocean floor and the subsoil thereof". ENDC/240, 18 March 1969.
   See also: ENDC/PV. 400, 3 April 1969.

4. Summary:

   The object of the draft treaty was to ban the use of the sea and ocean floor beyond a 12 mile coastal zone, for any military purpose. (Article 1).

   In order to verify compliance, all installations and structures on the sea bed were to be open to representatives of other states parties to the treaty "on the basis of reciprocity". (Article 2).

   In submitting this proposal, the Soviet Union contended that verification of a ban on all military activity on the sea bed would be simplified because a partial ban would require greater detail as to the verification procedures. A total ban would reduce the number of objects to be controlled since only peaceful objects would remain. As well, the Soviet Union contended that total demilitarization would reduce fears that the verification of objects on the sea bed would disclose military secrets.

A17(G69)

PROPOSAL ABSTRACT A17(G69)

1. Arms Control Problem:
   a) Regional arms control - sea bed

2. Verification Type:
   a) On-site inspection - general
   b) Remote sensors
   c) Complaints procedure - consultation and cooperation
   d) Review conference

3. Source:
   United States. "Draft treaty prohibiting the emplacement of nuclear weapons and other weapons of mass destruction on the sea bed and ocean floor". ENDC/249, 22 May 1969.

4. Summary:

The object of the draft treaty was to prohibit the emplacement on the sea floor of nuclear weapons, other weapons of mass destruction and their related launching facilities (Article 1).

To verify compliance parties were to be "free to observe activities of other states on the sea bed" provided that this observation did not interfere with such activities or otherwise infringe existing rights under international law. Should such observation still leave doubts unresolved, parties were to consult and cooperate with a view to removing these doubts (Article 3 (1)).

A review conference was to be held five years after the entering into force of the Treaty. One of the purposes of this conference was to "take into account any relevant technological developments" (Article 5). This conference was to consider whether additional rights and procedures of verification should be adopted. (Article 3 (2)).

PROPOSAL ABSTRACT A18(G69)

1. Arms Control Problem:
   a) Regional arms control - sea bed

2. Verification Type:
   a) On-site inspection - general
   b) Remote sensors
   c) Complaints procedure - consultation and cooperation
      - referral to Security Council
   d) Review conference

3. Source:
   United States/Union of Soviet Socialist Republics. "Draft treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the sea bed and the ocean floor and on the sub-soil thereof". ENDC/269/Rev.1, 30 October 1969.

4. Summary:

The object of the draft treaty was the prohibition of emplacement on the sea bed of nuclear weapons, other weapons of mass destruction and their associated facilities. (Article 1)

To verify compliance parties were to have "the right to verify the activities of other states parties to the Treaty" provided such verification did not interfere with these activities nor infringe existing rights under international law including freedom of the high seas. (Article 3 (1))

Each party could verify activities of others using its own means or with the assistance of any other state party. (Article 3 (2))

Parties were obligated under the treaty to consult and cooperate with the view to removing any doubts concerning compliance. If such consultation and cooperation did not remove doubts then any serious questions were to be referred to the Security Council.

PROPOSAL ABSTRACT A19(G69)

1. Arms Control Problem:
   a) Regional arms control - sea bed
2. Verification Type:
   a) On-site inspection - general
      - non-obligatory
   b) Complaints procedure - consultation and cooperation
      - referral to Security Council
3. Source:
   Canada. CCD/270, 8 October 1969.
   See also: - UNGA, A/C.1/992, 27 November 1969
   - ENDC/PV. 424,31 July 1969.
4. Summary:

The Canadian paper proposed that each party have the right to "verify through observation" the activities of other parties on the sea bed provided that such observation did not interfere with those activities or infringe on any rights recognized by international law. (Paragraph 1)

If reasonable doubts remained after such observation the party having these doubts and the party under suspicion were to consult and cooperate with a view to removing the doubts. Cooperative procedures were to include "appropriate inspection" of objects, structures, etc. which might reasonably be expected to be of a kind that had been banned. Parties in the region of the activities and any other party who so requested were to be notified of and permitted to participate in the consultations and cooperation. (Paragraph 2)

A special procedure was outlined for dealing with cases where the state responsible for the object, structure, etc. was not identifiable by observation. (Paragraph 3)

If doubts remained after consultation and cooperation, a complaint could be referred to the Security Council. (Paragraph 4)

Verification could be undertaken by any party using its own means or with the assistance of any other party. Such assistance could be sought directly or indirectly through the good offices of the UN Secretary General. (Paragraph 5)

All verification activities were to be conducted with due regard for the rights of coastal states. (Paragraph 6)

PROPOSAL ABSTRACT A20(T71)

1. Arms Control Problem:
   Regional arms control - sea bed

2. Verification Type:
   a) On-site inspection - general ("right of observation")
      - non-obligatory (Article 3 (2))
   b) Complaints procedure - consultation and cooperation (Article 3 (2))
      - referral to Security Council (Article 3 (4))
   c) Review conference (Article 8)

3. Source:
   Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea Bed and the Ocean Floor and in the Subsoil Thereof. (The Sea Bed Treaty).
   Opened for signature: 11 February 1971.
   Entered into force: 18 May 1972.
   Number of parties as of 31 December 1979: 68.

4. Summary:

   The verification provisions of the final Sea Bed Treaty were based in large part on the Canadian working paper presented in the First Committee of the General Assembly*. The provisions of Article 3 involve observation of activities in the sea bed zone followed, in the event of a suspected violation, by consultations between the states having reasonable doubts about an activity and the state responsible for the activity. Should these consultations fail to resolve the dispute, procedures are stipulated for notification of other parties in order to cooperate on further verification including inspection. It is unclear whether such inspection would be obligatory as regards the state which was being inspected. If the dispute still remains unresolved, there is a provision for referral to the Security Council.

   There is a special procedure for installations, devices, etc. whose state owner is not identified (Article 3 (3)). Verification may be conducted with the assistance of third parties including other states of the UN (Article 3 (5)). Finally, Article 3 (6) attempts to protect the rights of other states (including those using the high seas and coastal states) from being infringed when verification activities are undertaken.

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* See abstract A19(G69).

PROPOSAL ABSTRACT A21(T67)

1. Arms Control Problem:
   Regional arms control - nuclear weapons free zone (Article 4)
   - demilitarization
   - outer space

2. Verification Type:
   a) On-site inspection - general (Article 12)
   - obligatory
   - non-obligatory (Article 10)
   b) International exchange of information (Article 11)

3. Source:
   Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. (The Outer Space Treaty).
   Signed: 27 January, 1967.
   Entered into force: 10 October, 1967.
   Number of parties as of 31 December, 1979: 80.

4. Summary:
   Under the Treaty, nuclear weapons are prohibited from being placed in orbit or on any celestial body. Other military activity is prohibited on celestial bodies though not from earth orbit.
   All installations on the moon or other celestial bodies are open to inspection on the basis of reciprocity. Notice of an inspection must be given to ensure safety of inspectors and to avoid interference with the operations of the installation (Article 12). This inspection does not apply, however, to objects in earth orbit. Provision is also made, though not explicitly as part of the verification system, for permitting, on a voluntary basis, the observation of launches and flights of spacecraft (Article 10).

PROPOSAL ABSTRACT A22(A63)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   On-site inspection - general

3. Source:
   McGuire, B. "Disarmament: A Captive Inspectorate". In *Weapons Management in World Politics: Proceedings of the International Arms Control Symposium, December 17-20, 1962*, pp. 149-151. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:

This proposal suggests that, in order to overcome objections that on-site inspection is little more than legalized espionage and the objections that disarmament without inspection is unacceptable, a "captive" inspectorate should be established. It would have complete access to all facilities in the host country, but its capacity to transmit information would be restricted to prevent transmissions concerning the locations and characteristics of host installations. Communication would be restricted to information regarding the progress (or lack of it) towards disarmament.

To accomplish this the inspectorate would be segregated from the host population except during inspection trips. Special cities would be established, perhaps underground, so the host country could more easily monitor power input to the city, ascertain that radio messages were not being sent from the city, and exclude from the city electronic components which would be used for high power radio transmission. Measures would also be taken to prevent the corruption of inspection teams by host agents.

Moreover, aerial and surface photography should be expressly permitted and equipment to carry this out should be provided. Transportation of the inspectorate would be handled by the host, but the directions of the inspectorate in this regard should be followed, within clearly defined limits. Facilities for daily communication between inspection teams and inspectorate cities would be maintained by the host nation.

If the disarmament program were set in clearly defined stages, the inspectorates would report to their governments at the end of each stage. It would be best to have many short-term stages rather than a few broad, long-term stages. In this way, non-compliance by any given state would not handicap other states that had complied.

PROPOSAL ABSTRACT A23(A62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) On-site inspection - general
      - selective
      - sampling
   b) International control organization
   c) International exchange of information

3. Source:
   Blackett, P.M.S. "Steps Toward Disarmament". Scientific American 206, no. 4 (April 1962): 45-53.

4. Summary:

In the initial stage of the disarmament process, all parties would supply one another with a list of nuclear weapons and delivery systems under their control, as well as research and production facilities concerned with these systems. The exact location of these weapons and facilities would not be specified during this stage.

Upon completion of the inventory stage, an agreed number of weapons would then be destroyed and their destruction verified through on-site inspection by an International Control Organization. When destruction of these weapons is complete, a general inspection, using sampling techniques, would begin in order to verify the correctness of the numbers remaining after the agreed reductions had been verified.

Assuming all is found to be in order, it would be possible to proceed to further reductions or complete elimination of remaining armaments.

PROPOSAL ABSTRACT A24(A68)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) On-site inspection - general
   b) International control organization
   c) International exchange of information

3. Source:
   Burns, Richard Dean and Donald Urquidi. Disarmament in Perspective: An Analysis of Selected Arms Control and Disarmament Agreements Between the World Wars, 1919-1939. Los Angeles: California State College at Los Angeles Foundation, July 1968. 4 volumes. NTIS AD 696 940.

4. Summary:

The authors provide a detailed examination of interwar arms control agreements including a description of their provisions and an evaluation of their success or failure. Among the elements considered are the verification and control provisions of these agreements. The authors conclude, in general, that these provisions varied enormously between agreements, ranging from those which contained complex supervisory arrangements to those avoiding entirely formal verification. Two general observations are suggested. First, nations formulating arms agreements volunteered little mutual interest in or concern for international control machinery. Second, the authors' research indicates that there was "little relationship between compliance and verification; that is, a higher degree of compliance does not appear to have been directly related to the employment of more extensive supervisory instruments. Compliance seems to have depended more on whether the basic treaty provisions were imposed or negotiated, on whether the terms reflected concern for national security, and on the signatories respect for national honor" (Volume 4, p. 16).

To summarize briefly some of the more specific observations made by the authors:

1) Extensive supervisory powers were given the various Inter-Allied Control Commissions set up to enforce the Versailles Treaty and the similar accords with one other vanquished Central Powers. The methods used by these bodies included inspection.
2) The Straits Commission as provided for in the Lausanne Treaty (1923) represented a mixed system of control involving representation from both the Western powers and Turkey, the defeated Central Power. The Commission had the power of observing but not "inspecting".

3) None of the various naval treaties created formal control agencies, indeed such agencies were never considered. The Washington Treaty (1922) did provide for reconvening a conference of the parties if technological developments warranted it. The London Treaty (1936) provided for the annual exchange of detailed information on naval construction. It appears that the intention of the parties in the absence of formal verification arrangements in the treaties was to use their naval attaches to obtain the relevant information
4) Demilitarization agreements contained several different verification and control procedures.

PROPOSAL ABSTRACT A25(A65)

1. Arms Control Problem:
   Any arms control agreement
2. Verification Type:
   On-site inspection - general
3. Source:
   Lall, Betty Goetz. "Perspectives on inspection for arms control". Bulletin of the Atomic Scientists 21 (March 1965): 51-53.
4. Summary:

This paper represents a plea to the US and USSR to reexamine their positions and attitudes to inspection which is viewed as important for creating international confidence in arms control undertakings. In the course of a review of American and Soviet positions in the early sixties on the issue, the author presents a concise examination of the historical roots of the policies of the two governments.

Regarding the shift of US policy after World War Two from an anti to a pro-inspection position, Lall suggests three factors:
1) US desire to prevent proliferation of the atomic bomb,
2) trauma of the surprise attack on Pearl Harbor, and
3) the secretive nature of the USSR.

To explain Soviet policy, Lall suggests five factors:
1) isolation of the Russian people from other countries and a distrust of foreigners,
2) desire to protect the authority of the Soviet state,
3) fear that inspection by foreigners would represent espionage,
4) fear of exposing economic weakness, and
5) the possibility that the USSR may not want to live up to arms control agreements.

CHAPTER B

SELECTIVE ON-SITE INSPECTION

Selective on-site inspection involves a greater degree of restriction with regard to rights of access than is the case for general on-site inspection. Most frequently such restriction takes the form of permitting entry by inspectors only for the limited purpose of monitoring compliance with agreements concerning specific weapons systems and related facilities. From this central restriction flow certain others. First, access may be allowed only to a particular geographic location, for example, the site of a PNE as under the PNE Treaty, or the site of a facility for the destruction of CWs as in a number of proposals. Second, limitations may be placed on the activities which the inspectors may undertake at the place of inspection and on the information which they may acquire there. For example, inspectors may not be permitted to analyze the nature of a chemical agent which is in the process of being destroyed, for fear that sensitive information may be disclosed. Third, inspectors may also be limited as to the persons they may contact and the questions they may ask them.

In contrast to general on-site inspection systems, selective inspection reduces the degree of intrusion involved as well as costs and personnel requirements. It is also obvious from the foregoing discussion that the distinction between selective and general on-site inspection is more one of degree than of kind. There will clearly be a boundary area between the two categories where the distinction becomes blurred.

An important feature of the method is that it requires arms control agreements not only to define the weapons and materials to be controlled, but also to specify rules acceptable to those countries likely to be inspected which will as far as possible enable the inspectors to check the controlled items but nothing else.

In principle this approach is applicable to virtually all forms of arms control short of general disarmament. Moreover, since the views of the superpowers on what restrictions on inspection appropriate for their respective political systems and military deployments may not coincide, there has been an opportunity for other countries with a commitment to arms control to put forward verification proposals in the hope of finding a suitable compromise. These reasons may account for the large number of proposals included in this chapter.

A special case of selective inspection is worthy of separate mention. This is "verification by challenge". This in effect limits inspection to those situations where a party to the agreement has grounds for suspecting another participating country of evading the agreement, and challenges that country to prove its compliance. The expectation is that the accused country in order to prove its innocence would invite an investigation, which it could confine to matters relevant to the point at issue. The advantage of this approach is that an agreement may be reached without having to lay down rigid rules for inspection in advance and different compromises may be arrived at for the verification of each incident. However, it is perhaps less likely that these compromises will be satisfactory to all signatories. The basic philosophy is set out in proposal B71(A76), but the idea is present in many of the other proposals.

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PROPOSAL ABSTRACT B1(A61)

1. Arms Control Problem:
   Nuclear weapons - research and development

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - economic
   - personnel

3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In Arms Control: Issues for the Public, pp. 135-136. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

4. Summary:
   This proposal envisages a system of on-site inspection of weapons research and development laboratories and weapons testing facilities. Data-gathering techniques which would include monitoring of economic and personnel records, would comprise a central part of the verification system.

   A typology of research and development facilities based on the relative importance of activities could be developed, on which basis the frequency of inspections would be decided. A central control body would be charged with the processing and evaluation of the data collected by the inspection teams.

PROPOSAL ABSTRACT B2(G62)

1. Arms Control Problem:
   Nuclear weapons - fissile material "cutoff"

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - plant
   c) International control organization

3. Source:
   United Kingdom. "The technical possibility of international control of fissile material production". ENDC/60, 31 August 1962.

4. Summary:
   The paper foresees the creation of a Control Organization to verify the "cutoff". Its first duty would be to check the accuracy of declarations by states of the total quantity of fissile material. This would involve inspection of all existing stocks and records. Controls over current production would need to be instituted and these would be on-going. The Control Organization would also have to guard against the possibility of clandestine production plants.

The bulk of the paper is an assessment of the accuracy which is technically possible for verifying the "cutoff" using the UK nuclear organization as a model. With regard to control of current production there would not be much variation from country to country. The Control Organization should be able to verify current production of plutonium to within 1 and 2 per cent and of U_{235} to within 1 per cent.

The possibility of a violator successfully operating a large scale clandestine plant is remote. A smaller plant, however, might be able to secretly produce more fissile material than could be obtained by diversion from overt facilities.

The accuracy attainable for the verification of past production is much less than is possible for current production and would vary considerably from country to country. In those countries which have had a nuclear weapons programme, the Control Organization would be unable to guarantee that 10-20 per cent of the weapons had not been hidden.

The falsification of past records is possible but would require the bribing of a considerable number of staff. There would therefore be the possibility of some staff revealing the cheating. However, the fact that nobody revealed the forgery would not be evidence of the absence of forgery.

The Control Organization could not effectively check past production until its staff had been installed and had become familiar with the nuclear plants in the country concerned, a process which would take about a year. Since the checking of past production would be difficult and done only once, the UK paper suggests temporarily augmenting the regular staff with more highly qualified personnel for a period of six months. It would therefore take about eighteen months from the date of installation of the control system before declarations about past production of fissile material could be verified.

The UK paper estimates that the Control Organization would require about 1500 scientists and a total complement of 10,000 personnel. Independence in recruitment would be necessary. The paper also describes some of the working conditions and the duties of staff.

PROPOSAL ABSTRACT B3(G64)

1. Arms Control Problem:
   Nuclear weapons - fissionable material 'cutoff'

2. Verification Type:
   1) On-site inspection - selective
   - obligatory
   2) Short-range sensors - monitoring devices
   - sampling
   3) International exchange of information - declarations.

3. Source:
   United States. "Working paper on inspection of a fissionable material cutoff". ENDC/134, 25 June 1964.

4. Summary:

The procedures described might,according to this paper,be applied by the IAEA regarding declared facilities, though the IAEA's organization and procedures would have to be strengthened. Inspection to detect undeclared facilities would be conducted on an adversary basis.

Each nuclear power would declare, annually:

1) all U_{235} separation plants, chemical separation plants and reactors, and
2) the production of fissionable material needed for allowed uses and production schedules for each facility continuing to operate.

Each nuclear power would have the right to question the declaration of another and if the other did not satisfactorily justify its declaration, to withdraw from the treaty.

Inspection of shutdown production facilities would be relatively easy and foolproof. After an initial inspection to ensure the facility had been shutdown, subsequent inspections would be irregular and with only a few days notice.

U_{235} separation plants would have to be inspected to ensure only declared plants were operating and doing so within declared limits. Inspection would involve:

1) ground access to the perimeter of the facilites and continuous observation of the perimeter,
2) measurement of electrical power input into the plant,
3) measurement of uranium input and output, and
4) sampling of uranium tailings.

Regarding reactors, the nuclear powers should agree to accept IAEA inspection on a phased basis or a similar inspection scheme.

Chemical separation plants produce plutonium, U_{233} and unconsumed uranium from spent reactor fuel. Close monitoring is necessary. Inspectors would require complete access to the facility at all times. Procedures would provide for:

1) a design review,
2) maintenance of adequate records and submission of reports, and

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B4(G66)

3) inspections to account for material and to detect diversion. Alternatively, a similar amount of material of the same type not previously subject to international safeguards might be placed under such safeguards.

There would be a limited number of adversary inspections conducted of suspected undeclared facilities. These would involve internal inspection of the plant or, in the case of sensitive facilities, appropriate external inspection procedures such as environmental sampling, external observation and measurement of electrical power consumption. The inspected party could take reasonable precautions to prevent observation of sensitive activities by the inspectors provided they could still determine whether or not prohibited activities were occurring. A procedure for initiation of these inspections would need to be developed.

PROPOSAL ABSTRACT B4(G66)

1. Arms Control Problem:
   Nuclear weapons - fissionable material "cutoff"

2. Verification Type:
   a) On-site inspection - selective
   - IAEA safeguards

3. Source:
   United States. "Working paper on transfer of fissionable material obtained by the destruction of nuclear weapons". ENDC/172, 8 March 1966.

4. Summary:
   This proposal for the destruction of nuclear weapons was linked to an American proposal for a "cutoff" of fissionable material used in weapons. The fissionable material obtained from the destruction of nuclear weapons would be transfered to peaceful purposes under IAEA or similar safeguards. The USA would destroy a sufficient number of its nuclear weapons to obtain 60,000 kg of U_{235}. The Soviet quota would be 40,000 kg. Agreed amounts of plutonium would be obtained in a similar manner.

   The nuclear weapons to be destroyed would be transported to designated depots for disassembly and destruction. The destruction would be demonstrated to the nationals of both parties and to neutral observers in accordance with agreed procedures. Demonstration procedures to be acceptable would have to ensure that no confidential information, vital to national security or likely to lead to nuclear proliferation, was disclosed.

PROPOSAL ABSTRACT B5(G69)

1. Arms Control Problem:
   Nuclear weapons - fissionable material "cutoff"

2. Verification Type:
   a) On-site inspection - selective
      - IAEA safeguards
   b) International control organization

3. Source:
   United States. ENDC/PV. 401, 8 April 1969.

4. Summary:

   The "cutoff" proposal is intended to restrict the military use of fissionable material. The essential elements of this proposal are:
   1) a halt of all production of fissionable material for military purposes.
   2) continued production only for peaceful uses, and
   3) the use of the IAEA to safeguard the nuclear material in each state's peaceful nuclear activities and to verify the continued shutdown of closed fissionable materials production facilities.

   It is this third element which is a departure from previous American proposals which involved substantial elements of adversary inspection, especially with regard to the search for undisclosed facilities.* The US was, at the time of this proposal, prepared to accept the approach to verification adopted in the Non-Proliferation Treaty for non-nuclear weapons states, that is, use of IAEA safeguards and inspection.

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* See, for example: ENDC/134, June 26, 1964; ENDC/172, March 8, 1966; and ENDC/174, April 14, 1966.

P6(G79)

PROPOSAL ABSTRACT B6(G79)

1. Arms Control Problem:
   Nuclear weapons - fissionable materials 'cutoff'

2. Verification Type:
   a) On-site inspection - selective
   - IAEA safeguards
   b) International exchange of information - declarations

3. Source:
   Canada. CD/PV.39, 5 July 1979.
   See also: CD/PV.4, 25 January 1979.

4. Summary:
   Canada believes that several preparatory steps are necessary before any ban on the production of fissionable materials takes place. These include:
   a) collection of accurate information on the total production of fissionable material and production facilities;
   b) the declaration of ceilings on stocks of fissionable material for weapons purposes; and
   c) the expansion of existing verification procedures especially the administration of full scope safeguards on a non-discriminatory basis.

   The key to the operation of the cutoff is confidence in full disclosure and in accurate verification.

5. Selected Comments of States:
   Several other countries expressed ideas similar to Canada's. Australia (CD/PV.28, 19 April 1979; PV.79, 17 April 1980) stated that such a ban would involve the development of a comprehensive system of full-scope safeguards to be administered by the IAEA and the application of such a safeguards regime to all peaceful nuclear facilities in both non-nuclear weapon states and nuclear weapon states. The Netherlands (PV.28) suggested that the nuclear safeguards system of the IAEA could be applied to the whole peaceful nuclear fuel cycle of the nuclear weapon states together with the transfer of all military enrichment and reprocessing plants to the peaceful cycle. An important feature of this idea is that all countries would accept the same type of verification, removing a discriminatory feature of present safeguards application. Japan (CCD/PV.801, 17 August 1978) also supports the extension of IAEA safeguards to the nuclear weapons states.

PROPOSAL ABSTRACT B7(T68)

1. Arms Control Problem:
   Nuclear weapons - proliferation
   - peaceful nuclear explosions

2. Verification Type:
   a) On-site inspection - selective
   - IAEA safeguards (Article 3)
   b) International control organization
   c) Review conference (Article 8 (3))

3. Source:
   Treaty on the Non-Proliferation of Nuclear Weapons. (Non-Proliferation Treaty).
   Signed: 1 July 1968.
   Entered into force: 5 March 1970.
   Number of parties as of 9 December, 1979: 111.
   Number of NPT safeguards agreements in force as of 31 December 1979: 67.

4. Summary:*

The NPT prohibits transfer of nuclear weapons or explosive devices by nuclear weapon states to any recipient whatsoever (Article 1). Non-nuclear weapon states also agree not to receive such devices nor to develop or manufacture them (Article 2).

Concerning verification, non-nuclear weapons states undertake to conclude safeguards agreements with the IAEA "with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices" (Article 3 (1)). Such safeguards under the NPT are to apply to "all source and special fissionable material in all peaceful nuclear activities within the territory" of the non-nuclear weapon state, or carried out under its control anywhere.

Parties also undertake not to provide "(a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear weapon state" whether a party to the NPT or not, unless the source or special fissionable material is subject to IAEA safeguards (Article 3 (2)).

The safeguards required by Article 3 are to be implemented in such a way as not to affect the inalienable rights of parties to develop, produce and use nuclear energy for peaceful purposes nor the right to participate in exchange of material, equipment, or information on the peaceful use of nuclear energy (Article 3 (3) and Article 4).

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* See also abstract B13(I75) dealing with the NPT review conference.

Non-nuclear weapon states parties conclude safeguards agreements with the IAEA either individually or in groups of states. Negotiation for such agreements must commence immediately upon deposit of instruments of ratification or accession and the agreements must enter into force not later than 18 months after negotiations begin (Article 3 (4)).

Article 5 allows for making available to non-nuclear the benefits of PNEs but under "appropriate international observation and through appropriate international procedures ..." established by a body on which there would be "adequate representaiton of non-nuclear weapon states".

PROPOSAL ABSTRACT B8(I68)

1. Arms Control Problem:
   Nuclear weapons - proliferation
2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
   b) Records monitoring - plant
   c) Short-range sensors - monitoring devices
   d) International exchange of information - reports to international body
   e) International control organization.
3. Source:
   International Atomic Energy Agency. "The Agency's safeguards system (1965, as provisionally extended in 1966 and 1968)". INFCIRC/66/Rev.2, 16 September 1968.
   See also: "IAEA activities under Article III of the NPT". NPT/CONF.II/6, 14 July 1980.
4. Summary:
   INFCIRC/66/Rev.2 outlines the elements to be included in Safeguards Agreements between the IAEA and states which are not parties to the NPT. This model represents one of the two basic safeguards systems operated by the IAEA.* In contrast to the INFCIRC/153 system the objective here is to ensure that special fissionable and other materials, services, equipment, facilities and information are not used in such a way as to further any military activity (paragraph 2 of INFCIRC/66). It applies only to specific imports of nuclear materials, equipment and technology, not to the entire

* For the other model (INFCIRC/153), see abstract B10(I72).

peaceful nuclear industry in a state. Also, it seeks to prevent use of the safeguarded materials for any military purpose not simply for nuclear explosions.

Many of the elements found in the INFCIRC/153 safeguards system are found also in this system including the requirements to provide design information to the Agency (paragraphs 30-32), to keep accounting and operational records (pa. 33-36), to implement a system of reports to the Agency (pa. 37-44), and to permit Agency inspections (pa. 45-54). The Agency is also obligated to prevent disclosure of sensitive information (pa. 13-14).

Several differences between the two systems should be pointed out, however. First, generally, the specifications in INFCIRC/153 for the elements outlined above tend to be considerably more detailed than in INFCIRC/66. Second, there is no explicit mention of a national accounting system nor are any specific requirements for such a system specified in INFCIRC/66. The central importance of the national accounting system to IAEA efforts does not come through as it does in INFCIRC/153. Nor are the containment and surveillance elements of the safeguards system mentioned.

There are less limitations (pa. 45-54) placed upon the access allowed inspectors in INFCIRC/66. The exemptions from safeguards which are permitted differ somewhat between the two documents with INFCIRC/153 being more generous, though amounts in both cases are small. Provisions are present in INFCIRC/66 which allow for suspension of safeguards in some circumstances unlike INFCIRC/153 (pa. 24-15).

The circumstances under which safeguards terminate also differ somewhat with INFCIRC/153 being more restrictive (pa. 26-27). In the INFCIRC/66 system there is no clear indication of when nuclear material becomes susceptible to safeguards in contrast to the NPT system. International transfers are also treated differently; in INFCIRC/66 the main effect of an international transfer is to terminate safeguards (pa. 28 and 26).

No provisions for the settlement of administrative disuputes are outlined in INFCIRC/66. Noncompliance can lead to similar sanctions by the Agency as in INFCIRC/153.

Special procedures for reactors (pa. 56-58), nuclear material outside principal nuclear facilities (pa. 59-68), reprocessing plants (Annex I) and conversion and fabrication plants (Annex II) are also spelled out in INFCIRC/66.

PROPOSAL ABSTRACT B9(I70)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
   b) Records monitoring - plant
   c) Short-range sensors
   d) International exchange of information - reports to international body
   e) National self-supervision
   f) International control organization

3. Source:
   International Atomic Energy Agency. Safeguards Techniques. Proceedings of a Symposium held in Karlsruhe from 6-10 July 1970. 2 volumes. STI/PUB/260.

4. Summary:
The papers in these volumes review experience gained in applying safeguards. Treatment is more theoretical than in Safeguarding Nuclear Materials* of 1975. There are 66 papers (60 English, 4 French and 2 Russian) broken down into the following chapters:

Volume I - Safeguards Experiments and Experience (17 papers),
- Design of Safeguards Material Control Systems (11),
- Material Control System Experience (5), and
- Panel on Assessment of Burn-Up, Isotopic Abundance and Related Measurements at the Reprocessing-Input Point (7).

Volume II - Quantitative Safeguards Techniques (10),
- Qualitative Safeguards Techniques (4),
- Views on Systems Analysis (3), and
- Systems Analysis (9).

Each paper is accompanied by an abstract in English.

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* See abstract B12(I75).

PROPOSAL ABSTRACT B10(I72)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
   b) Records monitoring - plant
   c) Short-range sensors - monitoring devices
      - sampling
      - seals
   d) International exchange of information - reports to international body
   e) National self-supervision
   f) International control organization

3. Source:
   International Atomic Energy Agency. "The Structure and content of agreements between the Agency and states required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons". INFCIRC/153/Rev.1, June 1972.
   See also: - Safeguards. Vienna: IAEA, (1977?).
   - "IAEA activities under Article III of the NPT". NPT/CONF.II/6, 14 July 1980.

4. Summary:*

   INFCIRC/153 outlines the elements which should be included in Safeguards Agreements between the IAEA and individual states or groups of states made pursuant to the Non-Proliferation Treaty. This model sometimes referred to as 'full-scope' safeguards represents one of the two basic safeguards systems operated by the IAEA.** The object of the NPT safeguards regime is to monitor all source or special fissionable material in all peaceful nuclear activities within the territory of a state or under its jurisdiction or control anywhere so as to ensure that such material is not diverted to produce nuclear explosives (paragraph 1 of INFCIRC/153).

   Three fundamental principles underlie the model safeguards system represented by INFCIRC/153. First, the basic intent is to deter the diversion of nuclear material through the risk of early detection (pa. 28). Second, this is to be accomplished with the minimum interference possible so as not to impede the peaceful use of atomic energy (eg. pa. 4). Finally, the basis of the IAEA safeguards system lies with the comparison between the

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* The following description is based primarily on the Safeguards pamphlet.

** For the other model (INFCIRC/66/Rev.2) see abstract B8(I68).

B10(172)

information provided by the inspected party and that provided through the independent verification and inspection performed by the Agency (eg. pa. 7 and 31).

In the NPT safeguards regime there are three key legal documents. There is first, the Safeguards Agreement between the Agency and the state involved, which contains an undertaking by the state to accept safeguards, a statement regarding general exemptions, an outline of the requirements of each party and the safeguards procedures to be applied. Subsidiary Arrangements between the Agency and the state provide further details for executing the Agreement (pa. 39). Finally, Facility Attachments detail the safeguards to be applied to each facility.

Material Accountancy:

Material accountancy is the prime means of Agency verification (pa. 29). It involves the collection of measurements and other determinations which enable the state and the IAEA to keep track of the location and movement of nuclear material. Specifically, it consists of "the initial determination of physical inventory for a material balance area; the perpetuation of a book inventory based on the original determination and subsequent measured inventory changes; verification and updating of the book inventory by periodic physical inventory measurements; and the submission by the State of reports to the IAEA to enable the Agency to maintain a parallel set of accounts which are subject to verification and particularly comparison with the records kept at the facility" (p. 24, Safeguards). It is the comparison between book inventory and actual physical inventory of nuclear material which forms the basis of material accountancy. Differences are termed "material unaccounted for" which are analyzed to determine whether losses or diversions have occurred.

The main focus of material accountancy is the material balance area (MBA) which is an area such that all material entering or leaving is measurable and in which an inventory of the material situated there can be determined when necessary. Measurements are taken at key measurement points (KMPs). Both MBAs and KMPs are specified in the Facility Attachments.

The IAEA relies heavily on the national accounting and control system of the state for accountancy data (pa. 31). The Agency does, however, require that a number of features be incorporated into the national system (pa. 32) including:

1) a measurement system for determining flow and inventory of nuclear material,
2) a means for evaluating measurement accuracy,
3) procedures for identifying and evaluating shipper/receiver measurement differences,
4) procedures for taking physical inventory,
5) procedures for evaluating unmeasured inventory and losses,
6) a system of reports and records for each MBA,
7) a means for checking accounting procedures, and
8) procedures for submission of reports to the IAEA.

The form of the accounting records kept by the national system is at the discretion of the plant operator provided that several features are present (pa. 56 and 57) including:

1) a record of inventory changes,
2) a record of measurement results, and
3) a record of adjustment and correction.

In addition, the Agency requires the facility to maintain operating records for each MBA in which several specific types of data must be recorded (pa. 58).

A system of reports to the IAEA is also demanded of the facility operator (pa. 59-69). The initial report is submitted within 30 days of the last day of the month during which the Safeguards Agreement enters into force and it forms the basis of the Agency's parallel accounting system. It is essentially a listing of the physical inventory of nuclear material in each MBA. The Agency can visit the facility to verify the information in the initial report as it can with regard to other types of reports.

The inventory change report informs the IAEA of material movements. Notes attached to this report indicate the operations performed during the movements.

Each facility periodically takes a physical inventory of its nuclear material. When this is done the facility operator should submit a material balance report for each MBA. One of the items of data to be included in this report is "material unaccounted for".

Finally, if evidence is uncovered that nuclear material may have been lost or if any containment measure has been affected, a special report to the IAEA is mandatory.

The key to verification in the IAEA safeguards system is the right to conduct inspections (pa. 71-82). The basic purpose of all three types of IAEA inspections - ad hoc, routine and special - is to perform independent measurements and observations for comparison with the information submitted by the state. Secondarily, inspections also permit the application and servicing of IAEA containment and surveillance procedures. The frequency, scope and limitations of inspections depend on the type of material involved and the sophistication of facility management and national control schemes. Inspections may be periodic or continuous or without notice as long as agreed constraints are not exceeded. Regarding costs, generally each party bears its own expenses.

Inspectors are chosen for their competence and integrity with consideration also given to an equitable geographic representation. The Agency's Director General submits names of potential inspectors to the state to be inspected. The state has the right to refuse any inspector, however, persistent refusal of candidates will be brought to the attention of the Agency's Board of Governors (pa. 9).

When an inspection is decided upon, the state is notified and given relevant information about the visit. During the inspection, the Agency's inspectors might:

1) examine records,
2) make independent measurements,

3) check measurement and control equipment,
4) observe facility measurement, sampling and calibration procedures, and
5) request duplicate or additional samples and measurements.

Inspections are restricted in that inspectors:
1) are accompanied by state representatives,
2) can not operate any equipment, and
3) do not enjoy unlimited access.

The Agency is also obligated to prevent disclosure of commercially sensitive information acquired in the course of exercising its duties (pa. 5).

Containment and Surveillance:

In addition to material accountancy, the IAEA safeguards system employs two other verification means: containment and surveillance. Containment takes advantage of existing structural characteristics at a facility and involves the use of seals and other devices to prevent changes in the contents of an area without the Agency's knowledge. Surveillance unlike containment involves detection rather than prevention of the movement of material. It includes both human and instrumental observations to monitor plant activities.

Starting Point, Termination and Exemptions:

Safeguards are applied to nuclear material when it reaches a certain composition or level of purity (pa. 34). They cease, generally, when either the material is sufficiently diluted so as to be non-recoverable or it is transferred out of the state (pa.12). There are also provisions included in each Safeguards Agreement for several exemptions of material which would otherwise fall under safeguards (pa. 36-38). In addition,the NPT excludes from coverage nuclear material used in non-proscribed military activities and in non-nuclear activities.

The Design Review:

Practically, the first step in implementing NPT safeguards is the Design Review (pa. 42-58) during negotiations on the Subsidiary Arrangement when the state supplies the IAEA with information on the design of its existing facilities. The Design Review permits the Agency to identify the features of particular facilities which are relevant to safeguards application. On the bases of this design information the Agency defines MBAs and KMPs, establishes records, reports and verification requirements, and selects containment and surveillance techniques. The Agency is entitled to verify the accuracy of the design information provided by the state. The results of the Agency's Design Review are reflected in the particulars of the Facility Attachments which outline the operational details of safeguards at specific facilities.

International Transfers:

Special procedures are specified in INFCIRC/153 regarding safeguards requirements and procedures for the international transfer of nuclear materials under the NPT (pa. 91-97). As for other features of the NPT safeguards system, the Safeguards pamphlet provides useful tabular summaries of these provisions.

Disputes:

Provision is made for disagreements of an administrative nature to be submitted to the IAEA Board of Governors or to an arbitral tribunal (pa. 20-22). When the Agency is unable to verify non-diversion of safeguarded material the state may be required to take certain actions within a reasonable time to enable verification, or procedures for non-compliance may be initiated by the Board of Governors (pa. 18-19). These procedures include notification of IAEA member states and the UN Security Council and General Assembly. Ultimately, IAEA-sponsored material and technical assistance may be recalled and the violating state suspended from the IAEA.

Actual costs, number of inspections conducted and other details of the Agency's safeguards program are given in "IAEA activities under Article III of the NPT" cited above. These figures, which cover up to 1979, indicate that the implementation of safeguards is becoming a proportionately bigger share of IAEA activities.

PROPOSAL ABSTRACT B11(G74)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
   \- IAEA safeguards
   b) International control organization

3. Source:
   Sweden. CCD/PV. 647, 30 July 1974.

4. Summary:
   The IAEA should extend its safeguards systems to include a system of physical protection of all stockpiles of nuclear material. The Agency itself should stockpile excess material. Essentially, this means the internationalization of the management of nuclear material, to watch and protect it in order to prevent nuclear proliferation.

PROPOSAL ABSTRACT B12(I75)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
   b) Records monitoring - plant
   c) Short-range sensors
   d) International exchange of information - reports to international body
   e) National self-supervision
   f) International control organization

3. Source:
   International Atomic Energy Agency. Safeguarding Nuclear Material. Proceedings of a Symposium held in Vienna from 20-24 October 1975. 2 volumes. STI/PUB/408.

4. Summary:

The papers included in these volumes emphasize actual practical experience in the operation of material control systems, non-destructive measurement techniques and safeguards procedures.

There are 86 papers, broken down into the following chapters:

Volume I - General (4 papers),
- State Systems of Accounting and Control (11)
- Physical Protection of Nuclear Materials (3),
- Information Systems and Real-Time Material Control (10),
- Safeguards and Material Control Experience (9), and
- Probability and Safeguards (7).

Volume II - Instrumentation and Measurement Methods (20),
- Containment and Surveillance (4),
- Non-Destructive Measurements (2),
- Measurements in Reprocessing Facilities (2),
- High-Temperature Gas Reactors (3),
- Mixed-Oxide Fuels (6), and
- Non-Destructive Measurements of Reactors and Reactor Fuels (5).

Each paper is accompanied by an abstract in English.

PROPOSAL ABSTRACT B13(I75)

1. Arms Control Problem:
   Nuclear weapons - proliferation
   - peaceful nuclear explosions

2. Verification Type:
   a) On-site inspection - selective
   - obligatory
   - IAEA safeguards
   b) International control organization

3. Source:
   Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons. "Final declaration". NPT/CONF/35/1, Annex 1, 1975.
   See also: United Nations. Press Release. NPT/56. 7 September 1980.*

4. Summary:
   1. Review of Article 3

   The conference expressed the hope that all states having peaceful nuclear activities will establish and maintain effective accounting and control systems and welcomed the IAEA's readiness to assist states in so doing. It recommended intensified efforts towards standardization and the universality of application of IAEA safeguards while ensuring that safeguards agreements with non-nuclear weapons states not parties to the treaty, are of adequate duration, preclude diversion of any nuclear explosive devices and contain appropriate provisions for the continuance of the application of safeguards upon re-export. The conference recommended that more attention be given to the improvement of safeguards techniques, instrumentation, data handling and implementation in order to ensure cost effectiveness.

   The conference urged the establishment of common export requirements concerning safeguards particularly through extending application of safeguards to all peaceful nuclear activities in importing states not parties to the Treaty. The conference urged further elaboration within the IAEA of concrete recommendations for the physical protection of nuclear material in use, storage and transit, including principles relating to the responsibility of states, with a view to ensuring a uniform, minimum level of effective protection for such material.

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* The second NPT Review Conference of July 1980 failed to reach agreement on a substantive final declaration. Instead it reproduced the working papers presented by various governments.

B13(175)

2. Review of Article 4

The conference recommended that any nuclear assistance agreements should give weight to adherence to the Treaty by the recipient states. In this connection measures of cooperation might include increased and supplemental voluntary aid provided bilaterally or through multilateral channels such as the IAEA's.

The conference recognized that regional or multinational nuclear fuel cycle centres may be an advantageous way to satisfy, safely and economically, the needs of many states while at the same time facilitating physical protection and the application of IAEA safeguards.

3. Review of Article 5

Nuclear explosive services should be provided to non-nuclear weapons states by nuclear weapons states and be conducted under the appropriate international observation procedures called for in Article 5 and in accordance with other applicable international obligations. The IAEA is the appropriate international body through which PNEs should be made available to any non-nuclear weapon state. The IAEA is urged to commence consideration of the special international procedures contemplated in Article 5.

PROPOSAL ABSTRACT B14(G77)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
      - general
   b) Remote sensors
   c) Short-range sensors
   d) International control organization

3. Source:
   United States Congress. Office of Technology Assessment. Nuclear Proliferation and Safeguards. Washington, D.C.: 1977.

4. Summary:

The report identifies three routes to proliferation:

1) diversion of material from civilian programs,
2) construction of facilities specifically designed to produce nuclear weapons materials, and
3) purchase or theft of fissile material.

Of these, most attention has, in the past, been paid to the first.

Four levels of control effort are specified, one of which is the detection of attempts to acquire fissile material through the use of safeguards or intelligence activities. Safeguards are defined as "sets of regulations, procedures, and equipment designed to prevent and detect the diversion of nuclear materials from authorized channels" (p. 262). The report describes and evaluates US domestic safeguards as well as those of the IAEA. With regard to the latter the report concludes that it appears the IAEA will succeed in developing and implementing improved equipment and techniques for monitoring light water reactors. Onload reactors such as CANDU may prove harder, requiring the stationing of observers at plants. With regard to enrichment and reprocessing plants, it is essential to develop advanced containment and surveillance systems. Given adequate manpower and technical and financial assistance the safeguards system should be able to improve as the size of facilities under safeguards increase.

Several problems with the present IAEA safeguards system are identified:

1) the limited power of response of the IAEA,
2) restrictions imposed by proprietary interests,
3) failure of facility designs to integrate the application of safeguards, and
4) dependence on inspector quality and morale.

A number of policy implications are also outlined in the report regarding the IAEA safeguards systems. First, safeguards technology

could be quickly upgraded through more extensive use of multi-redundant cameras, seals, and portal monitors with full-time remote alarm systems monitoring by inspectors. Current restrictions on the operations of cameras and recording devices could be lifted. New technology could and is being developed. Controls to prevent procedural lapses could be made more strict. Real-time accounting systems would also enhance the timeliness of detection.

The IAEA should also be assured that funding, staffing and technical competence are augmented at a rate commensurate with global expansion of nuclear facilities. This includes a high quality recruitment and training program as well as high salaries. New funding mechanisms to finance the IAEA might be considered such as a tax on nuclear power.

The IAEA should also be provided with the authority to search for undeclared facilities including the right to instigate unannounced field investigations with full access to the territory of a state. The IAEA safeguards should be extended to the civilian reactors of France, the USSR and the PRC.

Safeguards should also be extended to cover acquisition through imports or diversion of plutonium for military non-weapons purposes.

Agreement should be sought on a common plan of action and graded sanctions for safeguards violations.

A standard text for multilateral and bilateral safeguards agreements should be created. This would form a basis for supplier states to demand that recipients submit all their peaceful nuclear activities to safeguards.

The interface between IAEA safeguards and national materials accounting systems should be improved such as through standardized measuring and accounting systems.

In addition to safeguards, national intelligence gathering capabilities are important, according to the report, especially for detecting undeclared dedicated facilities and purchase/theft routes to the acquisition of nuclear materials. Sources of intelligence include:

1) political reporting from embassies,
2) other human intelligence,
3) monitoring communications,
4) overflights,
5) satellites, and
6) atmospheric sampling.

Effective responses to violations will mean the pooling of nuclear intelligence.

PROPOSAL ABSTRACT B15(A79)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
   b) Short-range sensors

3. Source:
   Imai, R. "Non-proliferation: A Japanese point of view". Survival XXV, no. 1 (January/February 1979): 50-56.

4. Summary:

Unless safeguards are effective no arrangements (eg. international fuel banks or multinational reprocessing) can meet basic non-proliferation objectives because the international community would have no tool to detect and deter violations. Safeguards conceived of as a technical fix based only on careful accounting of nuclear material have been found ineffective in certain cases. Specifically, such a safeguards system cannot deal with large bulk material handling facilities like reprocessing plants or with "abrupt diversion" in which a large quantity of weapons-usable material is diverted within a very short time.

The present safeguards system was never intended to handle unlikely scenarios and to catch diverters red-handed; rather it was conceived as a means to deter states from engaging on weapons-oriented nuclear activities.

Imai suggests that an effective international safeguards system should include the following characteristics:

a) Safeguards should apply to the entire fuel cycle within a state and should employ not only material accountancy control but also advanced technologies to detect the physical removal of nuclear material from facilities as well as computerized checks on the material flow to detect anomalies within the national fuel cycle. It should be based on the multiple application of safeguard measures based on different principles which will raise the level of operational confidence of the deterrence system.

b) The system should employ technical means to extend the "critical time" for nuclear materials so that diversion will become more time-consuming and costly.

c) Rather than trying to prevent diversion, the system should look for indications of weapons-oriented anomalies within the peaceful fuel cycle. The existence of secret plutonium handling or uranium-enrichment plants or unexplained refusals to accept inspections should be considered more serious than excessive "material unaccounted for".

d) The safeguards system should be directly and promptly connected with some international arrangement for making political judgements on reports of anomalies and for imposing sanctions.

e) The way safeguards apply should differ between states accepting full fuel cycle coverage and offering important national control and protection structures, and those which do not.

PROPOSAL ABSTRACT B16(I80)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
      - IAEA safeguards
   b) Short-range sensors
   c) International control organization

3. Source:
   International Nuclear Fuel Cycle Evaluation. INFCE Summary Volume. Vienna: published by the International Atomic Energy Agency, 1980. STI/PUB/534.

4. Summary:

The reports of the eight INFCE Working Groups include a great deal which is relevant to the verification of non-proliferation undertakings. Much, however, relates to measures that are intended to improve control of nuclear materials and technology which will thereby indirectly facilitate verification.

The reports identify those points in nuclear fuel cycles which are sensitive to the danger of diversion of materials and equipment to weapons related purposes. These points are:

1) fresh fuel containing enriched uranium or plutonium,
2) uranium enrichment,
3) reactors,
4) spent fuel storage,
5) reprocessing, including plutonium storage and mixed oxide fuel fabrication, and
6) spent fuel or waste disposal.

The summary volume and the reports of the Working Groups provide a detailed assessment of the dangers of proliferation for each of these points.

Three means of minimizing the danger of proliferation are identified by the INFCE. The first of these are technical measures which have a powerful influence on reducing the risk of theft but only a limited influence on reducing the risk of state level

proliferation. Four categories of technical measures are specified:

1) measures to reduce the presence of weapons-usable materials in separated form in the fuel cycle,
2) measures to use radioactivity to protect those materials from diversion,
3) measures to protect them by the use of physical barriers, and
4) the use of lower enrichment levels for research reactor fuels.

If successful in reducing the number of routes to theft or diversion of materials, such technical measures should facilitate verification by enabling verification bodies to concentrate their efforts elsewhere.

Potentially more important than technical measures for reducing proliferation dangers are institutional measures. These include "a range of undertakings by either governments or private entities to facilitate the efficient and secure functioning of the nuclear fuel cycle and encompassing commercial contracts, intergovernmental arrangements, technical assistance programmes, international studies, non-proliferation agreements, supply assurances and international and multinational institutions" (p. 44). The purpose of these arrangements is to support and strengthen existing mechanisms of cooperation in peaceful use of atomic energy, the non-proliferation regime and the IAEA. Like technical measures these institutional measures are likely to facilitate verification by reducing the burden on verification organizations.

The third means of reducing proliferation dangers are improved safeguards, which relate directly to verification. The summary report describes briefly the existing international safeguards regime of the IAEA. While the Working Groups in their reports did not identify significant problems with the methods applied to existing plants, further improvement to existing techniques was foreseen as necessary to meet safeguards objectives at reasonable costs in connection with technologies for uranium enrichment, industrial-scale reprocessing of irradiated fuel and mixed oxide fuel fabrication, all of which involve the possibility of access to special nuclear material in a form usable for nuclear weapons. Such improvements should include:

1) taking into account the needs of safeguards when designing facilities,
2) enhanced containment and surveillance, and
3) improved methods of materials accountancy.

The INFCE concluded that effective international safeguards are essential to the nuclear power industry and the additional effort involved in safeguards is of importance. The summary volume and the reports of the Working Groups give a more detailed assessment of safeguards needs in relation to the points of the nuclear fuel cycle which are specified as sensitive to proliferation.

B17(A80)

PROPOSAL ABSTRACT B17(A80)

1. Arms Control Problem:
   Nuclear weapons - proliferation

2. Verification Type:
   a) On-site inspections - selective
      - obligatory
      - IAEA safeguards
   b) Records monitoring - plants
   c) International exchange of information - reports to international body
   d) National self-supervision
   e) International control organization

3. Source:
   Imber, Mark F. "NPT safeguards: The limits of credibility". Arms Control 1, no. 2 (September 1980): 177-198.

4. Summary:

The author critically evaluates the NPT (INFCIRC/153) safeguards regime according to five "common-sense" criteria:

1) whether the safeguards system applies common rules and procedures to all states,
2) whether the system applies to all aspects of the nuclear fuel cycle in each state,
3) the technical rigour of the system,
4) the credibility of sanctions, and
5) provisions for review and amendment.

After reviewing in detail the INFCIRC/153 system on each of these criteria the author concludes that there are several inadequacies in the system. The most significant of these are:

1) The permissive exception of the EURATOM-IAEA Safeguards Agreement is unfortunate in the context of the first criteria.
2) Regarding the second criteria, the exemption of non-proscribed military uses and mining and ore processing are problem areas.
3) Regarding the third criteria, the rigour of the system is weakened by limits to material accountancy accuracy relative to volume of materials subject to safeguards This is compounded by limits placed on the timeliness of detecting diversion and upon the activities of inspectors.
4) The sanctions available to the Agency are entirely inadequate, and
5) The lack of provisions for renegotiating Safeguards Agreements hinder improvements to the rigour of the system.

PROPOSAL ABSTRACT B18(G71)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions

2. Verification Type:
   a) On-site inspection - selective
   b) International control organization

3. Source:
   Netherlands. CCD/PV. 512, 29 April 1971.

4. Summary:
   An international body should be authorized to satisfy itself that only nuclear devices already tested are being used for peaceful applications. Reference is made to an IAEA document* which proposes that any nuclear device supplied to a non-nuclear weapon state by a nuclear weapon state must be specified as to its characteristics. This would make it unlikely that any untested military device could be used, and therefore that any valuable military information could be derived by the nuclear weapon state from the PNE.

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* GOV/1433.

PROPOSAL ABSTRACT B19(I73)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions

2. Verification Type:
   a) On-site inspection - selective
   b) Short-range sensors - monitoring devices
   - seals

3. Source:
   International Atomic Energy Agency. "Guidelines for the international observation by the Agency of nuclear explosions for peaceful purposes under the provisions of the Treaty on the Non-Proliferation of Nuclear Weapons or analogous provisions in other international agreements". INFCIRC/169, 16 January 1973.

4. Summary:

The basic purpose of international observation is to verify that Articles I and II of the NPT are not violated in the course of conducting a PNE. Such observation is required when the PNE is carried out through the IAEA or pursuant to bilateral agreements under Article V of the NPT or other international agreements.

The observation will be undertaken according to a specific agreement with the countries involved concluded 60 days before the transport of the nuclear device from the nuclear weapon state. Among the IAEA's responsibilities are:

- provision of an adequate number of observers,
- carrying out only those activities needed to perform its observation functions in a manner to avoid hindering the PNE; and
- informing all IAEA members of actions which contravene the NPT.

The responsibilities of other parties include:

- planning and conducting PNEs so as to prevent disclosures of design information,
- providing an opportunity for observation, and
- cooperating with Agency observers.

Among the provisions of the Observation Agreement will be the requirement for sufficiently detailed information on the project necessary for observations including description of transportation cannister, emplacement of the device and the predicted on-site physical effects of the explosion, together with detailed plans for the observation including a description of equipment to be used by the observers.

Observation will begin when the device leaves the nuclear weapon state except for the purpose of affixing seals to the device. Surveillance will continue on a 24-hour per day basis. Continuous

visual observation is desirable but other techniques may be used if the parties to the observation agreement consider them adequate. These methods include:

- technical means of surveillance (eg. security seals),
- exterior observation of buildings to verify entry of authorized personnel only,
- observation of the surface of the emplacement area after emplacement, and
- appropriate inspection to ensure no attempt to obtain radioactive material.

After the detonation the observers will determine whether the device has been detonated (eg. using ground motion instrumentation). The observers will also determine whether the explosion took place in accordance with the declared purpose of the PNE.

Within 90 days of the PNE detonation, the observers are to report to the Director-General of the Agency who will issue a Record of Observation and report to the Board of Governors.

In the case of PNEs conducted for emergency purposes (eg. oil well fire) special measures may be taken consistent with the guidelines above.

Parties to the Observation Agreement have the right to refuse specific observers. If there is repeated refusal of all observers, the Director General can refer the matter to the Board of Governors for appropriate action.

The Agency will give 3 weeks notice of the arrival of the observers. Further details of the actual visits of the observers are also outlined in the Guidelines.

PROPOSAL ABSTRACT B20(G75)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions

2. Verification Type:
   a) On-site inspection - selective
   b) International control organization

3. Source:
   Canada. CCD/PV. 672, 15 July 1975.

4. Summary:
   A PNE capability and a nuclear weapon capability have become indistinguishable. For a non-nuclear weapon state to have an independent capacity to conduct PNEs is incompatible with

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OPERATIONAL RESEARCH AND ANALYSIS ESTABLISHMENT OTTAWA
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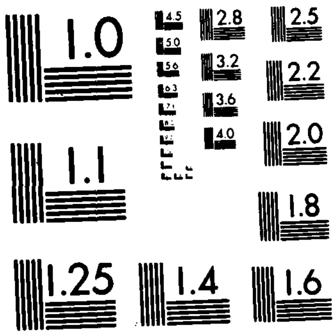

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

non-proliferation objectives since the knowledge gained from PNEs has military applications. No form of international observation of the PNE can prevent this; nor can such verification ensure that the state conducting the PNE has not already developed or that it is not in the process of developing a nuclear weapons capability. Therefore, non-nuclear weapons states should obtain peaceful benefits of nuclear explosions only through the services of present nuclear weapon states. Such services must be conducted under the international observation and international procedures required by Article 5 of the Non-Proliferation Treaty and in accordance with other applicable international obligations as stated in the first NPT Review Conference's Final Declaration. The IAEA is the body through which non-nuclear weapon states should receive PNE benefits.

PROPOSAL ABSTRACT B21(G76)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions
2. Verification Type:
   On-site inspection - selective
3. Source:
   Sweden. "The Test Ban Issue". CCD/481, 26 March 1976.
4. Summary:
   An essential problem with regard to a comprehensive test ban is to avoid the possibility that PNEs will be used to develop and test military devices. This problem can be solved through the use of expert observation and on-site inspection of PNEs. One possibility would be to monitor the composition of radioactive debris produced at the explosion site and thereby check that only nuclear devices of well-known design had been used. Another quite effective way would be to ensure, by expert inspection, that the blasts are not used for diagnostic measurements of the explosion in its very early stages.

PROPOSAL ABSTRACT B22(T76)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions
   - partial test ban

2. Verification Type:
   a) On-site inspection - selective
   - obligatory
   b) Short-range sensors - monitoring devices
   c) Seismic sensors
   d) International exchange of information
   e) Complaints procedure - consultative commission

3. Source:
   United States/Union of Soviet Socialist Republics. "Treaty between the USA and the USSR on underground nuclear explosions for peaceful purposes" and Protocol. (The PNE Treaty).
   CCD/496, 23 June 1976.
   Signed: 28 May 1976.
   Submitted for ratification - to US Senate: 29 July 1976.
   - to USSR Supreme Soviet: 11 August 1976.
   See also: United States. CCD/PV. 719, 10 August 1976.

4. Summary:

The following is a summary of American statements in PV. 719. The Treaty together with the Threshold Test Ban Treaty (TTBT)* establishes a comprehensive system of regulations governing all American and Soviet underground tests. These Treaties cover all underground explosions permitting blasts outside specified test sites only when conducted for peaceful purposes**. The PNE treaty also governs tests by either party on the territory of other states.

The Treaty sets a limit of 150 kt on any single PNE, a yield limit identical to that of the TTBT. "Group" explosions are also covered, meaning several individual explosions in such close spacial and temporal proximity that teleseimic monitoring cannot distinguish them. The Treaty provides that an aggregate yield of a group shall not exceed 1500 kt. In the case of such group explosions, the Treaty provides that observers from the verifying side will have the right to be present on-site before, during and after the explosion, where they will be permitted to identify each

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* See abstract I3(T74).

** There is an agreed statement attached to the PNE Treaty which makes it clear that developmental testing of PNEs is not to be considered a peaceful application and therefore must be conducted at designated nuclear weapons test sites under the TTBT.

individual component explosion, measure its yield and confirm that the circumstances of the blast are consistent with its stated peaceful purposes.

In order to measure the yield, the verifying personnel can choose to bring their own equipment to the site of the blast or they can use equipment provided by the country conducting the explosion. In the former case, there is a procedure for shipment of two identical sets of equipment to a port of entry of the other party, which would then choose the set to be used in the verification process. Within each of these sets are, in turn, duplicate components for making measurements and recording data. After the explosion, another selection procedure, this one by an agreed process of chance, will allow the verifying side to retain one of the two identical sets of measurement and data recording components while the other party may retain the remaining set for a specified time. In this way the rights of both sides are protected - the right of the verifying side to a valid set of measurements and the right of the other side to assurance that the equipment is not being misused to acquire unwarranted information.

When the yield of a group explosion is between 500 and 1500 kt the observers have the additional right to deploy a network of seismometers in the vicinity of the emplacement points of the explosion in order to ensure that no undeclared explosions are detonated along with the group. Similar procedures for selecting and using this equipment to those described above apply in this context.

For blasts between 100 and 150 kt, observers will be present if the need for their presence is mutually agreed on the basis of information made available by the party carrying out the explosion or by the verifying side. Under these circumstances the principal job of the observers will be to confirm geological and other data in order to assist teleseismic monitoring. It should be noted that observers also confirm geological and other information provided by the party conducting the blast when aggregate yields are above 150 kt.

The scope of the observers' functions increases with the aggregate yield of the blast because at higher yields there would be greater opportunity for evading detection of a violation of the 150 kt limit on individual explosions (i.e. detonating unannounced blasts of a yield over 150 kt under cover of a group explosion).

Below 150 kt, unless the presence of observers is agreed upon, the Treaty provides for verification on the basis of national technical means, supplemented by detailed information supplied by the party conducting the explosion. These national technical means, assisted by such data, provide adequate assurance that individual blasts will not be conducted with yields greater than 150 kt. There is a scaling of yields and verification measures with respect to the amount of information provided. For each explosion with an aggregate yield greater than 50 kt information would be given about purpose, location, date, planned yield, depth, geology, number of explosives and relative locations, specific geological features affecting the determination of yield, and confirmation of purpose. This information would be provided within 30 days of the commencement of emplacement of explosives. For explosions of lower yields the information requirements decrease. For yields of 75 kt or greater more extensive information is required. For explosions with aggregate yields exceeding 100 kt the information must be provided at least 100 days before emplacement. For all blasts, additional information including the actual time and the aggregate yield must be provided not later than 90 days <u>after</u> the explosion.

The PNE Treaty also provides that PNEs must conform to other international agreements of the parties (e.g. the Partial Test Ban Treaty, and the Non-Proliferation Treaty).

In addition to the provisions above for supplying information, the Treaty provides for the establishment of a joint Consultative Commission to facilitate additional exchanges of information, the establishment of procedures for the efficient implementation of the verification procedures, and consultations regarding any complaints.

The Protocol spells out in detail the procedures to be followed during observation, including the number of observers, the geographical extent of their access, the provision of certain information such as maps to assist in planning observation activity, and essential matters of a legal nature related mainly to immunities for the observers, their quarters, equipment and records. It also provides for certain additional constraints in order to assure functioning of the verification procedures and to limit the opportunity for gaining weapons related information. An example of the former is the set of formulae dealing with allowed maximum and minimum distances between individual explosions within a group. An example of the latter is the minimum depth requirement on any explosive emplacement point (explosives buried at a lesser depth could provide militarily significant information on blast and electromagnetic effects).

It should be noted that the PNE Treaty has been negotiated specifically to complement the weapons testing limitation of the TTBT. It does not deal with the problem of how to provide for PNEs in the context of a lower threshold or of a CTB.

PROPOSAL ABSTRACT B23(G63)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) On-site inspection - selective
                         - obligatory
   b) Short-range sensors - monitoring devices
   c) Seismic sensors

3. Source:
   a) Union of Soviet Socialist Republics. "Letters dated 19 December 1962 and 7 January 1963 from the Chairman of the Council of Ministers of the Union of Soviet Socialist Republics, addressed to the President of the United States of America". ENDC/73, 22 January 1963.
   b) United States. "Letter dated 28 December 1962 from the President of the United States of America to the Chairman of the Council of Ministers of the Union of Soviet Socialist Republics". ENDC/74, 31 January 1963.

4. Summary:

In the letter of 19 December, Khrushchev proposes, in addition to national detection systems, the establishment of three automatic seismic stations on the territories of each of the nuclear powers. In the Soviet Union he suggests they be set up in the Central Asian, Altai and Far Eastern regions and specifies particular locales which in the opinion of Soviet scientists would be most suitable. The Soviet Union is also prepared to agree that foreign personnel participate in the transport, and maintenance of apparatus at these locations provided measures are taken, if required, to prevent such visits from being used for espionage purposes.

In addition, Khrushchev agrees to accept on-site inspections of suspicious seismic events on Soviet territory. Referring to statements by US officials that 2-4 inspections would be sufficient, he states that the Soviet Union is prepared to accept 2-3 inspections per year. These visits could be carried out with precautions against their misuse for intelligence purposes.

In his reply of 28 December, Kennedy accepted the Soviet position regarding provisions to ensure against use of the inspections for espionage purposes so long as inspectors could satisfy themselves that they were actually at the intended location and had the freedom necessary to inspect the limited designated area. Regarding the number of inspections to be permitted each year, Kennedy states the US position to be that 8-10 are needed though he suggests that this could be reduced to a compromise figure if the USSR raises the number it is willing to accept.

Kennedy also expresses concern that the inspections suggested by Khrushchev appear to be limited to seismic areas and not include the whole of the Soviet Union. Finally, Kennedy does not feel that establishing three automatic stations, while helpful, goes far enough and he suggests other areas of the Soviet Union which would need to be covered.

In his letter of 7 January, Khrushchev states that the three automatic stations can be located wherever the US wishes and that the inspections could be carried out anywhere in the Soviet Union provided that reasonable precautions were taken against espionage.

(Note: Meetings of the US and Soviet officials after this exchange of letters failed to produce agreement).

PROPOSAL ABSTRACT B24(G63)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) On-site inspection - selective
                         - obligatory
   b) Short-range sensors - monitoring devices
   c) Seismic sensors

3. Source:
   United Kingdom and United States. "Memorandum of position concerning the cessation of nuclear weapon tests". ENDC/78, 1 April 1963.

4. Summary:
   This paper deals with verification arrangements to be applied to the nuclear weapons powers. The verification system proposed places primary reliance on national stations for the collection of seismic data, supplemented by the use of automatic stations plus a small number of on-site inspections to check suspicious unidentified events. The number of inspections per year which is acceptable to the UK and US is seven. These inspections would be reciprocal. Each side (i.e. the US and UK on the one hand, and the USSR on the other) would play the main role in the inspection though members of the international staff of the Control Commission would also be permitted to participate.

   Detailed arrangements for these on-site inspections are spelled out in the paper. Each state would have up to 60 days from occurence of a seismic event to designate it as one to be inspected. Procedures to be followed and required information are specified. The state where the event occurred would have one week to respond with any data it wished. During this week the designating state could retrieve the data records collected by the automatic seismic stations located on the territory of the receiving state. The designating state would have an additional week to evaluate this new information. If by the end of this week the designating state did not select the event, it would cease to be eligible for inspection.

Once an event was selected further information would be required from the designating state including proposed time of the inspection. The maximum area of the inspection would be 500 square miles.

The receiving state would have the right to indicate that a sensitive military installation was located in the area to be inspected. The designating state would then have the option of continuing the inspection but excluding the defence facility or cancelling the inspection. If a party felt this procedure was being abused it could withdraw from the treaty.

The receiving state would have responsibility for transporting the team to the inspection site. It would have the right to take measures to assure the security of its defence installations provided that the inspection team arrived promptly at the site. Examples of such measures are use of its own planes, and flight routes which avoid sensitive areas.

The inspection team personnel would be recruited from the inspecting nuclear side and from the international Commission. Fourteen technical experts from the nuclear state would be needed. Observers from the receiving state would also be present.

The inspection would include low-level aerial flights and photographs as well as ground teams given access throughout the area. Drilling would be permitted. If there was no drilling the duration of the inspection could be a maximum of six weeks unless extended by mutual agreement. Findings from the inspection would be submitted within 30 days of completion.

The automatic seismic stations would be built by the state in which they were located. The other nuclear side would supply recorders and other instrumentation, some of which would be sealed in vaults. Data at each station would be produced and recorded in both the sealed vault and in separate structure. The information in the unsealed structure would be periodically forwarded to the parties and the Commission. The other nuclear side would have the right to visit the stations 8 times each year to obtain the data from the sealed vaults and for routine maintenance.

PROPOSAL ABSTRACT B25(G66)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   On-site inspection - selective
   - non-obligatory

3. Source:
   Sweden. ENDC/PV. 247, 10 March 1966.

4. Summary:

If a suspicious event occurs on the territory of one party which other parties challenge then the standing of the suspected party in the international community would seem to make it imperative for that state to prove its innocence. In such a situation the suspected party might offer explanations and even invite an inspection.

If clarifying evidence is not brought forward, machinery for formal accusation would be set in motion, at first involving a demand by parties for clarification. A process of questioning and answering might then follow. Should these demands not be heeded or the information supplied be inadequate, a procedure for further recourse by the complainant would be necessary. Parties would have the ultimate sanction of withdrawal from the treaty, but such a recourse should not, and probably would not, be exercised rashly.

Sweden suggests that a further possible option should be open to a party which is concerned about the possible violation of the test ban but still hesitant to abrogate the treaty. The suspicious party might find it useful to challenge the suspected party to issue an invitation for inspection. If such a challenge, perhaps demanded by several parties, went unheeded - and particularly if it went unheeded on several occasions - the case for abrogating the treaty would be strong.

Given this, Sweden asks whether obligatory on-site inspection as opposed to voluntary inspection by invitation will make legal justification for withdrawing from the treaty any stronger.

PROPOSAL ABSTRACT B26(G69)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) On-site inspection - selective
   - obligatory
   b) Complaints procedure - referral to new international body
   c) International control organization

3. Source:
   United Kingdom. ENDC/PV. 404, 17 April 1969.
   See also:- "Working paper on the comprehensive test ban treaty". ENDC/232, 20 August 1968.
   - ENDC/PV. 381, 16 July 1968.

4. Summary:

In PV. 404 the UK proposes the creation of a committee to supervise the operation of a CTB treaty which would include a technical staff to clarify doubtful events. There need not be any automatic right of on-site inspection. Nevertheless the right should exist in certain circumstances.

An earlier working paper, ENDC/232, outlines the possible composition of this committee. It would be composed of representatives of three non-aligned states and a nominee of the UN Secretary General or the IAEA. Apart from the single UN or IAEA representative, the members of the committee would be government representatives assisted by scientific advisors rather than scientists themselves. The right of on-site inspection would be exercised only if the committee agreed by a 5 to 2 majority that a *prima facie* case existed. While the committee would have an ultimate right of on-site inspection, this right would be circumscribed by the procedure proposed, so that it could not be exercised improperly, but also it might not be exercised when it should be.

PROPOSAL ABSTRACT B27(G69)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) On-site inspection - selective
   b) International control organization
   c) Seismic sensors

3. Source:
   Nigeria, ENDC/PV. 411, 15 May 1969.
   See also: ENDC/246, 15 May 1969.

4. Summary:

Nigeria contended that verification by seismic detection should be supplemented by another form of verification to allay fears of possible violation. On-site inspection had been rejected by some because of fears over espionage. Nigeria referred to a UK proposal to establish an international committee of parties to the treaty to undertake on-site inspection.* Inspections, when necessary, should be conducted by a group of non-aligned countries that have signed the Non-Proliferation Treaty and possess the technological know-how to undertake such inspections. Because the inspectors would be from states who were parties to the NPT they would not be likely to engage in espionage. Because they would be from non-aligned states the inspectors would not be likely to act as an agent for others. Such an on-site inspection would be undertaken only if there existed strong evidence of a violation which could not be conclusively proven by seismic data.

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* See UK, ENDC/232, 20 August 1968, abstract B26(G69).

PROPOSAL ABSTRACT B28(A61)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - manned aircraft

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - economic

3. Source:
   Frisch, D. Arms Reductions: Program and Issues. New York: Twentieth Century Fund, 1961.

4. Summary:

The author begins by noting that missile production is organized in pyramidal fashion, with raw materials at the base and the missile at the top. There is increased specificity of product characteristics the higher up in the process one looks. On this basis, it is clear that inspection becomes more critical at higher stages in the pyramid. At the top, inspection amounts to counting inventories and checking for concealed missiles, while at lower levels, component parts must be accounted for. If the process of development and production seems to suggest that more missiles should exist than are accounted for in the inventory, a violation is indicated.

The author notes that records inspection would involve an excessively large amount of information to be evaluated and that monitoring inventories and production of certain critical components such as jet engines and fuels, airframes, etc. would constitute a more viable approach. Tight controls could be kept over such components.

PROPOSAL ABSTRACT B29(A61)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - manned aircraft

2. Verification Type:
   a) On-site inspection - selective
   - sampling
   b) Records monitoring - plant

3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In Arms Control: Issues for the Public, pp. 118-123. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

4. Summary:

In seeking to verify an agreement limiting, but not banning nuclear weapons and their delivery systems, this system would be composed largely of a data-gathering force. Components required for production of nuclear armaments would be classified in the following manner:

Type 1 plants: those producing "critical components", difficult to manufacture and easy to identify, such as high-precision gyros and rocket engines;
Type 2 plants: those producing one or more components of aircraft or missiles; and
Type 3 plants: all other manufacturing facilities.

Type 1 plants would require resident inspectors, Type 2 semi-random sample inspection every six months, and Type 3 semi-random sample inspection every year.

A records control centre would establish plant and product classification criteria, assign product code numbers, classify output information, etc. All plants would forward by mail complete copies of production, shipping and receiving records to the records control centre at specified intervals, retaining duplicate copies of such records to be picked up and checked against plant facilities by the field inspectors when they arrive. The field inspectors would periodically forward such duplicate records to the control centre by couriers for checking against the mailed reports.

Sampling techniques would be used extensively throughout the monitoring process.

PROPOSAL ABSTRACT B30(G62)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - plant
   c) Remote sensors.

3. Source:
   United Kingdom. "Preliminary study of problems connected with the elimination of rockets as nuclear delivery vehicles". ENDC/53, 1 August 1962.

4. Summary:

To control production of rockets the paper claims that it would be necessary to have resident inspectors at main assembly plants and proving grounds unless space research was internationalized. Also checking the records of principal sub-contractors and periodic visits to component manufacturers could be used. The UK paper suggests that the number of inspectors needed would be in the thousands.

The destruction of production facilities and bases could be verified only by inspection. Mobile launchers would, however, provide greater problems.

Clandestine production given suitable inspection would be less of a danger than clandestine storage of previously produced rockets. Illegal stocks of rockets could be hidden and extremely difficult to detect even with unrestricted inspection.

To ensure against aggressive developments in space, satellites and spacecraft should be subject to inspection at all stages of design and production and control should be exercised at assembly points and launching sites to ensure no illegal payloads were launched. A large number of inspectors would be needed.

PROPOSAL ABSTRACT B31(A62)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - manned bombers

2. Verification Type:
   a) On-site inspection - selective
   - progressive/zonal
   b) Records monitoring - personnel
   c) International exchange of information - declarations

3. Source:
   Woods Hole Summer Study. Verification and Response in Disarmament Agreements. Annex Volume I. Washington, D.C.: Institute for Defence Analysis: November 1962.

4. Summary:

This proposal deals with the verification system for an agreement reducing by stages over 3 years the number of strategic delivery vehicles possessed by the United States and the Soviet Union. The following components are suggested:

a) Initial declarations of total inventories would be required to determine the number of vehicles to be destroyed during each stage. "These declarations could be made implicitly by delivering the vehicles to be destroyed rather than through the explicit deposit of a written document" (p. 15).

b) Verification might be limited during the three year reduction period to monitoring the destruction of vehicles and to inspection of declared production facilities. Inspectors would establish procedures for verifying the absence of clandestine production and stockpiles. A limited number of inspection teams would begin by inspecting some of the larger cities or industrial centres; both the number of teams and the area covered would be gradually increased during the period of reduction.

c) At the end of the three year period, inspection procedures would be established to provide reasonable assurance that the production and deployment of delivery vehicles is held within the agreed limits.

d) The inspectorate might be given the right to conduct some hundred (this is apparently an arbitrary figure) inspections per year at selected industrial facilities, as well as continuous monitoring of declared production facilities and activities associated with related peaceful programs. Some pre-emptive inspections without advance notice should be allowed.

e) Only limited access to production facilities should be permitted the inspectorate. For instance, visits might consist of tours through selected factories and interviews with plant personnel. No records monitoring, blueprint examination or hardware testing would be allowed. Three man inspection teams are envisaged.

f) The inspectorate would fulfill other duties as well. It would conduct selected monitoring of the activities of professional personnel, especially those presently associated with aircraft and missile programs. It would be charged with carrying out sample inspections of retained force levels, with enough access to permit a count of the number of vehicles, without threatening the security of the deterrent force. The status of defensive measures, including air-defence, anti-missile defences and anti-submarine systems would be monitored as well.

PROPOSAL ABSTRACT B32(A80)

1. Arms Control Problem:
   Nuclear weapons - mobile ballistic missiles

2. Verification Type:
   On-site inspection - selective
   - sampling

3. Source:
   Berinati, V.J. and J.H. Henry. A Comparison of the Characteristics of Three Sampling Schemes for the Verification Inspection of Certain MX ICBM Systems. Arlington, Virginia: Institute for Defence Analyses, March 1980. IDA Paper P-1478. NTIS AD-A088580.

4. Summary:
   In order to verify the number of missiles deployed in an MX-type ICBM Multiple Protective Structure system, some type of periodic inspection may be necessary. This paper assesses three proposed sampling schemes for such verification. Each scheme is aimed at providing reasonable probability of detection with requiring inspection of an excessive number of shelters. The factors affecting each scheme which are compared include:
   1) detection probability,
   2) geographic distribution of shelters to be inspected,
   3) the number of occupied and empty shelters disclosed in the inspection,

4) the need for a master list of deployed missile locations, and
5) possible deployer cheating strategies.

The three schemes are examined on the basis of a single deployment model: 4000 shelters, 200 legal missiles and from 20 to 200 illegal missiles. The authors conclude that none of the three methods appears superior to the others on all the evaluation criteria.

PROPOSAL ABSTRACT B33(A70)

1. Arms Control Problem:
   Nuclear weapons - reentry vehicles
2. Verification Type:
   On-site inspection - selective
3. Source:
   Scoville, H. "Verification of Nuclear Arms Limitations". Bulletin of the Atomic Scientists 26, no. 8 (October 1970): 6-12.
4. Summary:

The author, while recognizing the excessively intrusive nature of his proposal, suggests that on-site inspection is the only means by which detection of MIRVed vehicles could be assured with absolute certainty. Such a system would include the right to inspect any deployed missile on sufficiently short notice so as to prevent substitution of re-entry vehicles. It would further involve access by the inspectors to the interior of the re-entry vehicle, or at the very least, the use at close range of some technique such as x-ray sensing in order to determine the number of warheads on a given missile.

It is recognized by the author that this system would be unacceptable to both the United States and the Soviet Union. Consequently, he suggests that a ban on testing of MIRVed vehicles, verified by national means should be attempted.

PROPOSAL ABSTRACT B34(A63)

1. Arms Control Problem:
   Nuclear weapons - missile tests

2. Verification Type:
   a) On-site inspection - selective
   b) International exchange of information
   c) International control organization

3. Source:
   Singer, J.D. Deterrence, Arms Control and Disarmament. Columbus: Ohio State University Press, 1963.

4. Summary:
   This proposal calls for all missile tests to be pre-announced as regards date, time, flight and orbit path, and payload characteristics. An international control agency would send observers to the launch sight prior to the flight to confirm the information provided by the nation conducting the test. Free access to all relevant launch facilities would be required. If all safety requirements were met, the test would proceed and the agency would assume responsibility for broadcasting all relevant data until the test was completed or the satellite was in orbit. All governments would have access to information regarding the test as broadcast by the agency.

PROPOSAL ABSTRACT B35(A61)

1. Arms Control Problem:
   Nuclear weapons - manned aircraft

2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - aerial

3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In Arms Control: Issues for the Public, pp. 126-127. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

4. Summary:
   This proposal envisages the verification of an agreement limiting the number of manned bombers to be retained by each country by means of on-site inspection of airfields and

factories producing aircraft. Initial disclosures of retained aircraft would be verified by inspection of airfields, while the veracity of the disclosure of airfield locations can be verified by random search and aerial photography. Intelligence sources would also be tapped to this end. Limits on aircraft production would be verified by on-site inspection.

PROPOSAL ABSTRACT B36(G62)

1. Arms Control Problem:
   Nuclear weapons - manned aircraft
2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - aerial
   \- radar
3. Source:
   United Kingdom. "Preliminary study of problems connected with the verification of the destruction of certain nuclear delivery vehicles". ENDC/54, 1 August 1962.
4. Summary:

Under the proposed system aircraft to be destroyed would be required to fly to a destruction centre. This would ensure that the machine was airworthy, and would make it more certain that operationally complete aircraft had been destroyed than if crates of components were delivered to the destruction centre.

If it were necessary to ensure that the planes were fully operational, they might be required to carry out certain exercises prior to destruction. For instance, the aircraft might be required to make a sortie at normal operating altitudes and speed to its full operational radius of action, drop practice bombs under specified conditions and then return to the airfield at the destruction centre.

Remote monitoring, using radar and aerial sensors could verify compliance with these requirements and could also ensure that other aircraft were not substituted during the course of the exercise.

These procedures would not require the disclosure of details of the aircraft's construction. If it were thought necessary to check the quality of the aircraft by means other than a test flight, a test centre might be set up.

To destroy about 500 aircraft the international inspectorate would require perhaps 10 key engineers, 20-30 supervisors and some clerical help.

PROPOSAL ABSTRACT B37(A58)

1. Arms Control Problem:
   Biological weapons - production
   - research and development

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - personnel

3. Source:
   Groupe, V. "On the Feasibility of Control of Biological Warfare". In Inspection for Disarmament, pp. 185-191. Edited by S. Melman. New York: Columbia University Press, 1958.

4. Summary:
   This proposal involves two related but distinct parts. First, each party to the control agreement would maintain a registry of the location of certain large and essential pieces of laboratory and pilot plant equipment. A registry of qualified bacteriologists and other professional specialists and their current assignments or location of employment would also be kept.

   Second, inspection teams composed of military intelligence experts, and some bacteriologists would inspect facilities known to produce bacteriological weapons, as well as certain other facilities connected with their production. An international science advisory board could serve in a consultative capacity.

PROPOSAL ABSTRACT B38(A70)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - plant
   c) Short-range sensors - monitoring devices
   - sampling
   d) International control organization

3. Source:
   "Controlling a Ban on Manufacture of Biological and Chemical Weapons". NATO Letter 18, no. 7-8 (July-August 1970): 17-19.

4. Summary:
   This is a description of the system used by the Armaments

Control Agency of the Western European Union to verify a ban on the production of CW agents in the Federal Republic of Germany (FRG). The FRG agreed inter alia not to produce CWs under the terms of the 1954 Protocol amending the Brussels Treaty. The monitoring system has been in effect since 1956.

> Control extends to all substances specified in a list together with their chemical formulae. This list is reviewed by experts from time to time and modified or supplemented as necessary ... .
>
> Excluded from controls are all apparatus, parts, equipment, installations, substances and organisms which are used for civilian purposes or for scientific, medical and industrial research in the fields of pure and applied science. Production controls apply to end-items and not to manufacturing processes. Accordingly, chemical factories as such are not subject to control but rather specifically designated, relevant products.
>
> Non-production controls apply to defined characteristic substances necessary for production. These "characteristic substances" are not chemical warfare agents but are rather deemed to be initial or key products without which prohibited warfare agents cannot be manufactured... The aim of controls at production plants is to ensure that the characteritic substances, at the controllable stage, are not used for the production of the prohibited chemical warfare agents....
>
> Chemical products which can be used both for military and civilian purposes are not deemed to be chemical warfare agents if the quantities produced do not exceed peaceful civilian requirements. The Agency is notified by the Federal Republic of Germany of the peaceful civilian requirement of such products and verifies that the quantities produced do not exceed peaceful civilian requirements. Hence this control is by its very nature a quantitative control.
>
> The initiative for field inspections lies with the Agency. After the competent national authority of the Federal Republic of Germany and the management of the factory concerned have agreed to the Agency's request to be allowed to carry out controls, the Director of the Agency appoints two to four officials of different nationality, one of them a national of the country in which the controls are to be carried out. A representative of the competent national authority assists the Agency in the execution of its controls in conformity with the treaty.
>
> During such controls the representatives of the Agency enquire about the organization, operation and production programme. Their questions are answered in so far as no business or production secrets are involved.
>
> The subsequent visit to the production plant covers only those departments where the decisive

B38(A70)
B39(G70)

phase of reaction occurs. The inspectors ask to be shown built-in measuring sensors so that they can verify the quantities of the product or pre-products employed in the production of a substance and the final output. If further clarification is required, the findings are compared with the factory's records or books.

Special attention is paid by the inspectors to the factory's safety regulations. They are visible, cannot be concealed, and, together with the lack of special equipment and installations indicate in the clearest possible way that no production of chemical warfare agents takes place....

The taking of samples as a means of control is considered by all experts to be useful and effective in special cases for identifying specific substances and determining whether they are prohibited agents of warfare. The high degree of toxicity of most of these substances poses the problem of liability in case of accidents or damages caused or suffered by inspectors.

The inspection is carried out in stages in order to avoid, as far as possible, any interference with the civilian sector...The Control Agency reports to the Council of the Western European Union annually. This report states the number of controls that have been carried out, the names of the firms concerned, and the outcome of the controls, indicating - but not specifying - any difficulties or problems that may have occured.

PROPOSAL ABSTRACT B39(G70)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) On-site inspection - selective
   b) Short-range sensors - sampling

3. Source:
   Japan. "Working paper on the question of the prohibition of chemical weapons". CCD/301, 6 August 1970.
   See also: CCD/344, 24 August 1971.

4. Summary:
   Japan claims that verification of a ban on CW production

will have to rely on recourse to ad hoc inspections based on a complaints procedure. In this regard reporting of production figures of certain chemical substances will be important for providing evidence to support any complaint.

The method of on-site inspection would use techniques similar to those developed to check the contamination of rivers or living things by agricultural chemicals. These include gas chromatography and coulometry detectors. Checks would be made for the prohibited agent itself, production precursors and waste products.

CCD/344 further elaborates on this method. What is needed is a highly sensitive means of microanalyzing a methylphosphorus bond (unique to nerve agents as opposed to other organophosphorus compounds). This might be done through gas chromatography. Using this method one could test for very small quantities of a substance in the liquid wastes from the plant, in the soil and dust around plant, in the production equipment, or in the workers' clothing.

If such a method of detecting methylphosphorus compounds were developed it might be possible to detect nerve agent production by checking the atmosphere or river water at a considerable distance from the plant. At present the method needs further testing.

PROPOSAL ABSTRACT B40(A74)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) On-site inspection - selective
   b) International exchange of information - declarations

3. Source:
   Scoville, H. "A Leap Forward in Verification". In SALT: The Moscow Agreements and Beyond, pp. 160-182. Edited by M. Willrich and J.B. Rhinelander. New York: The Free Press, 1974.

4. Summary:

Recognizing that economically sound procedures for producing organophosphorus compounds, for insecticides for example, are somewhat different than those required for producing organophosphorus CW agents, and that safety measures required for CW agent production are greater than those for insecticides, the author proposes measures that would simplify differentiation between the two. It might be agreed that the unusual procedures for CW production will not be undertaken for the insecticide industry without explaining such action to the parties to the agreement, and allowing on-site inspection of the specific plant to provide assurance that a chemical agent was not being produced. Further, countries could declare the extent of their production of industrial toxic chemicals and account for their use in order to provide assurance that significant diversion to military uses was not taking place.

PROPOSAL ABSTRACT B41(G79)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - plant
   c) Short-range sensors - monitoring devices
      - sampling
   d) International control organization

3. Source:
   Federal Republic of Germany. "Working paper on some aspects of international verification of non-production of chemical weapons: Experience gained in the Federal Republic of Germany".
   CD/37, 12 July 1979.*
   See also: - PV.42, 17 July 1979.
   - PV.29, 24 April 1979.

4. Summary:

Part I of the West German paper describes the practices and principles of the verification activities conducted by the Armaments Control Agency (ACA) of the Western European Union. Under the revised Brussels Treaty of 23 October 1954 the FRG agreed not to produce chemical weapons and the ACA was set up to verify this undertaking. ACA controls consist, first, of evaluating written information, supplied upon request and, second, of on-site inspections. These controls extend to substances which are specified on a list established and continuously reviewed by experts. Excluded from controls are equipment, installations and substances used for civilian and scientific research. This exclusion encompasses small, militarily irrelevant quantities of recognized CW substances used for medical purposes. Dual-purpose substances are not deemed to be CWs if the quantities produced do not exceed peaceful civilian requirements. The controls determine whether the quantities produced exceed those requirements.

Production controls are applied to end-items, not to manufacturing processes or chemical factories. Non-production controls apply to substances with characteristics which have been defined as necessary for the production of CWs though they are not CWs themselves. Controls start with the phase of production immediately preceding the completion of the end-item.

The initiative for on-site inspections lies with the ACA. Its director appoints from two to four inspectors of different nationalities including one from the country where the inspection is to occur. A representative from that country also assists in the execution of the inspection.

The inspection is carried out in stages so as to minimize interference. As soon as the inspectors are satisfied that the non-production

* See also abstract B38(A70).

commitment is being met, the control must cease. The first stage is the visit to the production plant which includes searching for special safety precautions. These precautions are highly visible and their absence together with the absence of special equipment and installations provide the clearest possible indication that no CWs are being produced. This inspection covers only those departments dealing with the decisive phase of reaction.

The second stage extends control to the employment of initial and intermediate products in the controllable stage. If there is still uncertainty whether CWs are being produced, the factory's records may be checked against instrument readings. The fourth and final stage involves taking samples to identify specific substances.

After the inspection, the inspectors make an oral report to the ACA's director and a written, classified report exclusively for the agency's file. Neither the factory concerned nor the competent national authority is consulted in the preparation of these reports. The representative of the country who has taken part in the inspection reports to the national authority concerned and this report is transmitted to the management of the factory.

The staff of the ACA are forbidden to reveal information obtained as a result of their duties. The annual reports of the ACA indicate the number of controls, the companies involved and the results but do not go into details. Special protection is also accorded to industrial, economic, commercial and scientific information.

Part II of the FRG paper discusses the results of a workshop held in that country from 12 to 14 March 1979 which was attended by experts from several countries. This workshop included visits to chemical plants. It demonstrated that:

- in the absence of safety precautions no super-toxic compounds can be manufactured in chemical industry plants,
- the absence of such safety precautions is perceivable in the course of a plant inspection and indicates the non-production of CWs,
- a rapid conversion of available production plants into CW producing plants is technically not feasible, and
- the chemical industry in the FRG does not object to the controls.

The workshop visits also indicated that any effective verification of a CW ban must include international control measures and that regular on-site inspection by an international control authority should be an indispensible component. Other international control measures such as near-site inspections (emission analyses), satellite monitoring, statistical control of production figures, and the consumption of raw materials and basic chemicals do not suffice to replace on-site inspection, nor can off-site inspections and the opto-electronic sealing of shut-down factories be a satisfactory substitute.

In Part III of its paper West Germany states two principles for practical verification of a world-wide CW production ban, based on its experience:

1) effective verification requires adequate on-site inspection of current production, and
2) such inspection can be conducted without impairing industrial

process and legitimate commercial interests of the plant concerned.

The necessary prerequisites of such verification are:

1) precise definition of CWs,
2) pure and applied research and civilian use should be excluded from controls,
3) information should be given to the control authority annually to ease the task of selecting factories eligible for non-production controls,
4) the controllable stages must be defined; specific substances must be defined as initial products,
5) non-production controls should be implemented gradually, and
6) the civil peaceful requirements of specific (ambivalent) chemical substances on the prohibited list should be roughly estimated and reported each year.

In PV29, the FRG representative added that the character and scope of suitable verification measures depends upon the nature and number of the prohibited agents. An objective definition of these agents such as that presented in the FRG working paper of 22 July 1975 (CCD/458) would greatly facilitate on-site inspections.

PROPOSAL ABSTRACT B42(G79)

1. Arms Control Problem:
   Chemical weapons - production
   - stockpiling

2. Verification Type:
   a) On-site inspection - selective
   - obligatory
   b) Remote sensors - sampling
   - satellites

3. Source:
   Denmark. CD/PV.44, 24 July 1979.

4. Summary:
   Verification procedures should be as little intrusive as possible. This could include monitoring of air and waste water samples collected even at a great distance from manufacturing sites. In addition, the possibility of making use of modern technology including observation satellites, should be explored. However, until non-intrusive methods have been sufficiently developed and an international consensus is subsequently achieved on their application, visits by a highly qualified international agency seem to be indispensable. Such visits, properly arranged, could be carried out without unjustifiable intrusion and without the disclosure of state or commercial secrets. An adequately controlled CW ban need not, therefore, await development of more sophisticated extraterritorial verification procedures.

PROPOSAL ABSTRACT B43(A80)

1. Arms Control Problem:
   Chemical weapons - production
   - stockpiling
   - destruction of stocks

2. Verification Type:
   a) On-site inspection - selective
   b) International exchanges of information

3. Source:
   Stockholm International Peace Research Institute. Yearbook of Armaments and Disarmament: 1980. London: Taylor and Francis, 1980, pp. 370-71.

4. Summary:
Abolishing a category of weapons which have already been used on a large scale in combat and have comparable mass destruction effects to that of nuclear weapons would involve important security aspects for the parties who would need to assure themselves that the proscribed items had actually been destroyed and were not being manufactured. Unilateral, unchecked declarations by governments would provide inadequate assurance. Self-verification exclusively by nationally constituted bodies would not be sufficiently important. Extra-territorial verification by national technical means is open to only a few states and is of limited use anyway. International control is therefore essential, including both sporadic and systematic on-site inspection. Sporadic inspection may be used to investigate allegations of clandestine production or illicit use. In the case of stockpiles of CWs there is no reliable substitute for systematic on-site monitoring of their destruction. There is evidence that such on-site inspection (sporadic or systematic) can be devised so as to rule out disclosures of legitimate commercial or military secrets.

To fill some inevitable gaps in the verification procedures adopted, several voluntarily undertaken confidence building measures might be used including:

a) official statements of national policies concerning CWs;
b) gradual removal of secrecy surrounding CWs through exchanges of information;
c) visits of foreign technical experts to relevant chemical facilities; and
d) attendance at military exercises by foreign observers.

PROPOSAL ABSTRACT B44(A80)

1. Arms Control Problem:
   Chemical weapons - production
   - destruction of stocks
   - destruction of facilities

2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - satellite

3. Source:
   Meselson, Matthew and Julian Perry Robinson. "Chemical Warfare and Chemical Disarmament." Scientific American 242, no. 4 (April 1980): 38 - 47.

4. Summary:

The authors contend that maintaining a chemical retaliatory capability or entering into an agreement to limit chemical weapons are alternative approaches to minimizing the threat presented by the chemical weapons of an adversary. While both approaches have their risks, the present situation for NATO reduces the attraction of the former and increases that of the latter. Specifically, NATO's greatly improved protective capability against chemical weapons, the availability of a wide range of conventional and nuclear weapons which overlap and overshadow the capabilities of chemical weapons, and, finally, political constraints on the development and deployment of a more effective chemical retaliatory force, all argue in favour of an arms control approach.

Existing intelligence gathering methods are insufficient for monitoring a CW agreement according to the US and other NATO countries. However, the authors contend, a verification system need not be able to detect all activities and facilities that would constitute a technical violation of the treaty. "What is required is a high likelihood of detecting chemical-warfare preparations on a scale large enough to constitute a major military threat" (p. 47). In this context, the present high level of NATO's chemical defence capability raises the scale of chemical-warfare preparation which would be required in order to constitute a serious military threat which, in turn, makes concealment more difficult and intrusive inspection less necessary.

One approach for reliable verification of destruction of declared stocks would be to transport them to one or more sites where their destruction would be observed by international inspectors. This process would require several years during which the participating countries could take other measures to assure themselves that the treaty was being implemented.

The elimination of declared production facilities could be monitored by satellite following restricted on-site inspections to ensure that the facilities were of the types declared.

The verification of the absence of undeclared stocks or facilities could be addressed by carefully designed measures based on the right to request on-site inspection where other methods had raised questions.

PROPOSAL ABSTRACT B45(G80)

1. Arms Control Problem:
   Chemical weapons - production
   - destruction of facilities

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - economic
   c) Remote sensors - sampling
      - satellites
   d) Short-range sensors - monitoring devices
      - sampling
      - seals
   e) International exchange of information
   f) International control organization

3. Source:
   France. "Control of the non-manufacture and non-possession of agents and weapons of chemical warfare".
   CD/106, 27 June 1980.
   See also: - "Elements of a reply by the French delegation to the questionnaire relating to chemical weapons submitted by the Netherlands to the Committee on Disarmament (CD/41)". CD/104, 26 June 1980.

4. Summary:

The prohibition on manufacture will be total regarding single purpose agents while production of dual purpose chemicals will be permitted for civilian needs. Control of non-manufacture would therefore cover exclusively the first category. In the case of dual purpose chemicals, control would ensure that amounts produced do not exceed levels needed for civilian needs and that any surpluses are not used in chemical munitions.

Single-Purpose Agents:

Non-manufacture should be monitored at two levels:

1) ensuring CW plant shut down or conversion to civilian use; and
2) ensuring plants producing related chemicals (eg. pesticides) are not converted to produce CWs (such conversion would be possible in a few months).

The first, essential step is registration by countries of all CW production facilities. However, only thorough on-site inspection can provide effective control. Fear of disclosure of military or industrial secrets in the case of super-toxic substances is not justified because, by definition, they are intended only for military use and, in the spirit of the agreement itself, there can be no military or industrial secrets in this area.

Other monitoring methods such as processing of statistical data provided by member countries and remote detection either by sensors based on satellites or on land outside the country being monitored,

are unreliable. Even if this lack of reliability could be offset by using several of these methods in combination, such a system would be too cumbersome and would not yield results that were certain.

Concerning processing of statistical data, the data is usually very incomplete and the content and presentation vary in different countries. In addition, there are considerable annual fluctuations in the data for reasons that have nothing to do with production of CWs and which may lead to unjustified suspicion. Furthermore, in a country producing large amounts of pesticides and consuming large amounts of raw materials, slight diversions which would be initially imperceptible could be used to manufacture large quantities of CWs. A great deal of technical work will have to be done before this technique can be used with any chance of success, especially regarding harmonization of data collection in member countries.

Although remote detection of CWs in gaseous effluents is theoretically possible, no experimental tests of these methods has yet been attempted and it is doubtful whether they are applicable in the near future.

The CW agreement should lay down procedures for ensuring that shut-down plants are not restarted. In order to avoid permanent and burdensome on-site inspection, unbreakable sealing devices could be used. Other surveillance methods - seismic detectors, and closed-curcuit television - have not been tested. All these measures require at least periodic presence by inspectors.

In the case of monitoring pesticide plants, thorough on-site inspection could involve disclosure of industrial secrets. To avoid this, two alternatives have been suggested: brief inspections and effluent analysis. The purpose of brief inspections would be to detect signs of unauthorized production of CWs. Particular attention would be paid to safety measures at the plant including:

- airtight processing units kept at less than atmospheric pressure to prevent leaks,
- presence of inert gas in vessels and an inert-gas rapid-purge system,
- gravity-flow movement of liquids,
- remote controls and alarm devices,
- masks and special impermeable clothing,
- 'hot' spaces entered by locks fitted with sprinklers,
- automatic sampling devices,
- emergency air and power supply, and
- special medical supervision.

Brief inspections, however, can only serve as a complement, enabling other indicators collected elsewhere to be confirmed.

Effluent analysis involves sampling liquid effluent and the air in the immediate vicinity of the factory. Concentrations of these samples permits analysis for presence of CWs or their degradation products. While these methods have proved themselves in the laboratorv, they have not been tried under practical conditions. Further refinement of the method is needed.

Dual-Purpose Chemicals:

The only available monitoring method here is statistical data analysis aimed at identifying production surplus to civilian needs. Efforts should be concentrated on detection of munitions filling facilities once a surplus has been identified.

In the view of France, the first monitoring procedure to be developed should be statistical data analysis which applies to verification of both single and dual-purpose chemicals. This will require each signatory to provide the following information:

- the nature, quantity and utilization of organophosphorus compounds, raw materials, intermediates and precursors;
- the nature, quantity and utilization of dual-purpose substances produced; and
- the proposed activities of newly constructed chemical factories.

Parties should also submit periodic reports on their compliance with the convention.

Only on-site inspection of an international character perhaps accompanied by the collection of samples can give adequate guarantees. Such inspection is essential both for systematic verification and for a check resulting from a challenge procedure. National verification should at least be accompanied by international procedures for monitoring declared production sites. Such procedures should include verification of non-reactivation of "mothballed" factories and monitoring of the environment of operating factories. Satellites might be suitable for the former purpose and periodically read "black boxes" for the latter. In all cases of a breach or a request for inquiry, on-site inspection by an international body should be accepted by the suspected state. It is therefore essential to establish an international body such as a Consultative Committee. In CD/105, France suggests that the committee include a permanent secretariat and a corps of inspectors as well as a specialized laboratory.

B46(G80)

PROPOSAL ABSTRACT B46(G80)

1. Arms Control Problem:
   Chemical weapons - production
   - stockpiling

2. Verification Type:
   a) On-site inspection - selective
   b) Complaints procedure - consultative commission
      - referral to General Assembly
      - referral to Security Council
   c) International control organization
   d) International exchange of information - declarations
   e) Short-range sensors - sampling
   f) Review conference

3. Source:
   Canada. "Organization and control of verification within a chemical weapons convention". CD/113, 8 July 1980.
   See also: CD/PV.45, 26 July 1979.

4. Summary:

Canada (CD/113) states that it is necessary that adequate verification measures be available in any CW convention. A Consultative Commission could meet regularly to review events and also at the request of parties. It alone, however, is unlikely to be able to adequately monitor verification and compliance.

An international verification control agency might be contemplated. It would be directed by an executive officer and would contain a secretariat to provide for co-ordination of necessary services and dissemination of information. It could also include inspection teams and other technical personnel for processing of economic information and scientific data including the testing of samples. The agency might report to the Consultative Committee as well as the UN. As a model for this international control organization, Canada, in PV.45, suggests the IAEA.

Each party would be required to establish a national verification agency to review national activities under the treaty as well as to report results and provide other information to the international agency. These national agencies would host international inspection teams and provide candidates for the international agency's staff.

Some on-site inspection will be required to monitor national activities. National agencies would act in this role in conjunction with international arrangements particularly at critical phases of some activities and in challenge situations. On-site sampling will be necessary for some activities and this must involve standardized techniques. When international inspectors are involved duplicate samples should be taken for analysis in national and international laboratories.

Other verification methods include: initial declarations, periodic exchanges of statements and review conferences. In addition,

bilateral discussions, appeals to the Consultative Commission and appeals to the UN Security Council or General Assembly might be included.

In PV.45, Canada supports the notion of implementing systems of verification in stages, with different approaches for the monitoring of different activities. Verification by challenge may be useful particularly in monitoring initial statements but it will have to be backed up by other systems such as national technical means and on-site inspections.

5. Selected Comments of States:
Belgium (CD/PV.98, 7 August 1980) supported the Canadian proposal.

PROPOSAL ABSTRACT B47(G81)

1. Arms Control Problem:
Chemical weapons - production
- research and development
- stockpiling

2. Verification Type:
a) On-site inspection - selective
b) International exchange of information

3. Source:
Sweden. "Prohibition of retention or acquisition of a chemical warfare capability enabling use of chemical weapons (4 annexes)". CD/142, 10 February 1981.

4. Summary:
The paper outlines several considerations relevant to the prohibition of a chemical warfare capability. One of the advantages of such a prohibition is that it may increase the effectiveness of verifying compliance with a CW convention since the number of activities proscribed is increased. The paper lists activities which might be included in the ban. Among the "undertakings" which would be spelled out in annexes to a convention banning a capability to use CWs are:
1) regular visits by observers to military units, military stockpiles and air fields,
2) on-site inspection when complaints about violations are made, and
3) provision of information to other parties either directly or through a consultative committee, regarding several activities such as: a) military CW protective posture,
b) general military education,
c) equipment for use of CWs, and
d) civil defence activities.

PROPOSAL ABSTRACT B48(G72)

1. Arms Control Problem:
   Chemical weapons - stockpiling

2. Verification Type:
   On-site inspection - selective

3. Source:
   United States. "Working paper on storage of chemical agents and weapons". CCD/366, 20 June 1972.

4. Summary:
The paper is based on US experience in storing CWs. It describes a number of the features of such storage facilities which may help to distinguish them from facilities for storing other munitions or chemicals. Three general characteritics are discussed:

1) Physical security: Generally, there is nothing unique to CW storage facilities in this regard apart from special warning signs, guards with protective masks, and air sampling devices.
2) Maintenance of stocks to prevent deterioration: Again there is nothing peculiar to a CW facility in this regard which could not be easily hidden.
3) Precautions for protection and treatment of personnel in case of accident: This can be achieved by regulating access to facility, providing protective clothing and decontamination facilities, and ensuring quick access to medical services.

The general conclusion reached is that while some indications may be visible under certain circumstances, it is difficult even when in close proximity to the CW storage facility to distinguish it from other types of storage facilities. Those features which are unique could be readily hidden if desired. Thus, it is questionable whether any of these features will be of much help in formulating a reliable system of verification.

PROPOSAL ABSTRACT B49(G74)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
   b) Short-range sensors - monitoring devices
      - sampling

3. Source:
   United States. "Working paper on chemical agent destruction". CCD/436, 16 July 1974.

4. Summary:

The paper describes the process of actual destruction of mustard agents in the US. It also discusses possible verification methods for monitoring destruction of these agents and perhaps others. Verification of destruction can be conducted in a variety of ways depending on the access accorded verification personnel. The degree of access varies from remote observation through closed circuit TV to free access and sampling. Verification can be undertaken at several stages in the process of destruction.

a) Transfer of Agent Containers, Unloading and Thawing:
The most recognizable indicators at this stage are:
   i) availability of decontamination equipment,
   ii) protective clothing and masks of workers,
   iii) warning signs, and
   iv) security measures.
These could be easily observed but also easily staged and thus are of questionable verification value.

b) Draining Containers:
This step provides the first opportunity for positive assurance that a toxic chemical is present, but full access for sampling is needed.

c) Incineration of Agent:
Verification at this stage provides the best assurance that a toxic agent is being destroyed. Sampling would occur just before the substance enters the furnace. Specimens of the salts resulting from incineration of the mustard agents could also prove useful. A third verification method might be to try to obtain a materials balance (i.e. the quantity of materials going in compared to amount coming out). For this method the system would have to be totally contained to prevent any loss of materials.

d) Scrubbing of Effluent Gases, Disposal of Salts, Decontaminsation and Disposal of Containers:
These steps do not seem to provide any important additional opportunities for verification.

P50(G76)

PROPOSAL ABSTRACT B50(G76)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks

2. Verification Type:
   a) On-site inspection - selective
   b) Short-range sensors - sampling

3. Source:
   Sweden. "Working paper on some aspects of on-site verification of the destruction of stockpiles of CWs". CCD/485, 9 April 1976.
   See also: CCD/PV.704, 22 April 1976.

4. Summary:
   Fears have been expressed that observation of destruction of CW stocks could be used to acquire military and industrial secrets.* Sweden proposes to alleviate this concern through the use of chemical tests which would determine the toxicity of the substance being destroyed but which would not disclose the chemical nature of the substance.

   The paper suggests that speciments be taken from the surroundings of the destruction site and analyzed in order to determine the toxicity of substances being destroyed. This "perimeter sampling" would be less intrusive than other methods. The analyses could be carried out in off-site laboratories or by "black boxes" on the site. The obvious drawback, the paper points out, is that no estimation can be made of the amount of agent being destroyed using this technique. However, chemical analysis of "perimeter" samples combined with toxicity tests of random samples of the agent might result in a fairly good assessment of the type of substance and the amounts being destroyed.

* See USSR. CCD/PV. 647, 30 July 1974.

PROPOSAL ABSTRACT B51(G76)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks

2. Verification Type:
   a) On-site inspection - selective
   b) Short-range sensors - monitoring devices
   - sampling
   - seals

3. Source:
   United States. "Verification of destruction of declared stocks of CW agents". CCD/497, 29 June 1976.

4. Summary:

The American paper continues the evaluation of possible verification methods for monitoring CW agent destruction, first discussed in CCD/436.* The paper commences by stating two assumptions:

1) the destruction is done thermally or chemically, and
2) the disposal facility is similar to that described in CCD/436.

Planning of the observation must be worked out cooperatively between the facility management and the observers. Before destruction begins observers would be given engineering drawings and a detailed technical description of the destruction process. They would then confirm this information by inspecting the plant to make certain that no diversion of the agent was possible. Periodic re-inspections would be necessary, to ensure that no illegal modifications to the facility had occurred.

The observers would be authorized to visit any area of the facility at any time to observe all activities. In addition, surveillance of certain areas could be done remotely using cameras and TV. Tamper-resistant seals might also be used to close off certain areas of machinery.

Verifying the quantity of agent destroyed might be done by monitoring the rate of flow into the destruction chamber. Verifying the nature of the agent might be done by toxicity tests and chemical analysis of samples taken periodically, and by monitoring waste products. Air sampling, a less intrusive technique, might be of assistance but it could not replace sampling of the agent stream.

The use of a tracer substance added to the agent stream might help ensure there was no diversion. In this regard another useful method, if the identity of the agent were known, might be the use of a material balance calculation to compare the amount of the waste products with the amount of agent entering the process. Finally, the observers would have their own technical facilities on the site.

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* See abstract B49(G74).

B52(G77)

PROPOSAL ABSTRACT B52(G77)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks

2. Verification Type:
   a) On-site inspection - selective
   b) Short-range sensors - sampling

3. Source:
   Union of Soviet Socialist Republics. "Verification of the destruction of declared stocks of chemical weapons". CCD/539, 3 August 1977.

4. Summary:

The main purpose of monitoring the destruction of declared stocks of CWs should be to establish and report:

1) the fact of the destruction of an agent of a certain type,
2) the quantity of the agent destroyed, and
3) the quality of the agent.

This paper is intended to describe one method for attaining these objectives.

The paper is based on the assumption that the destruction process will be under national control. As well, it is assumed that:

1) the chemical agents are destroyed by incineration or detoxification;
2) the planning of the destruction, removal of the agent from containers or warheads, and collection in special receptacles, are regarded as preparatory operations which are taken without the participation of controllers; and
3) the agents are transported to the place of destruction in special receptacles.

Quantity of the agent is determined by weighing it or by measuring its volume. As well, the density of the agent must be ascertained. The quality of the agent is determined by the "content, in percent, of the basic substance of the agent". The working paper provides formulae for calculating these figures and examples of the application of these formulae.

Since it is possible that the chemical agent may be non-homogeneous in quality, it is necessary to analze at least three samples - one at the beginning of the destruction process, one in the middle, and one at the end. The samples can be taken either directly from the receptacle or from the flow of the substance when it is being fed into the destruction facility. The final stage of laboratory chemical analysis should be the analysis of the extent of decomposition of the chemical agents destroyed.

PROPOSAL ABSTRACT B53(A79)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - stockpiling

2. Verification Type:
   a) On-site inspection - selective
   b) Records monitoring - economic
   c) Short-range sensors - sampling
   d) Remote sensors - satellites
   e) International control organization

3. Source:
   United Kingdom. Foreign and Commonwealth ffice. Arms Control and Disarmament Research Unit. "Verification of a convention on chemical weapons". March 1979 (Note: This paper is a research study only and does not necessarily reflect the views of the government of the United Kingdom).

4. Summary:

The paper evaluates several proposed methods for verifying a CW convention. Regarding the creation of elaborate international control organizations to conduct inspections, problems will arise over costs and fears of espionage. Such considerations suggest that a simpler form of control body would be more acceptable in the short term. One possibility is a control committee which would meet regularly or as required and appoint scientists to carry out particular inspections. If a more permanent inspectorate is ever needed than this committee could be modified accordingly. Ideally no state should be able to block the committee from acting. Inspections of civilian plants would have to be carefully conducted by chemical industry experts. Inspections must be prompt once suspicions are aroused.

Verifying a CW ban by monitoring published statistics about civilian chemical production would be of limited efficiency. Problems would arise in large industrialized countries where amounts produced are great and chances for diversion numerous. Even concentrating the monitoring on specific chemicals and specific factories would be of limited value unless there were inspections to verify the accuracy of the statistics. The possibility of evasion would still exist, however.

Effluent sampling (gaseous and liquid) might be a reliable additional form of verification despite some problems. Samples taken close to a civilian chemical plant might indicate the presence of suspicious chemicals. But the absence of such traces is unlikely itself to give sufficient confidence that no evasion has occured so as to make other forms of verification unnecessary.

Inspection of the chemicals entering a plant as raw materials could be a useful indicator of production of illegal CWs. The presence of certain kinds of machinery could also indicate evasions, though this must not be overestimated as a verification method because legitimate production processes may involve similar equipment. An exception is filling equipment for CW munitions which is quite distinctive. The presence of special safety precautions would mean that the facility would have to be kept under regular surveillance but it would not be positive proof of evasion.

Complete demolition of a CW production facility could be verified by satellite. However, partial dismantling or decommissioning would require inspection. Tamper-proof seals could be used but regular checks would still be needed. Conversion of a CW facility to civilian use would require a rigorous form of international inspection involving continual and regular visits.

To monitor destruction of CW stocks at least some test of the type of chemical being destroyed (to show that they are not pesticides for example) is necessary as well as some indication of the quantity being destroyed.

Locating hidden CW plants is a very difficult verification problem, particularly in advanced countries with tight internal political restraints. Random air and water sampling is unlikely to be useful in a large country. Detection by satellite would be very difficult if the clandestine plant was part of a large industrial complex. Satellites, also, are available only to a few countries and any verification system depending on them would be fundamentally discriminatory. The most likely way of detecting hidden plants remains traditional intelligence methods. Similarly there is no way hidden stockpiles can be located except by traditional means of intelligence. Once located inspection would be essential to allay suspicions. Refusal to allow inspection could be taken as proof of guilt. If national means of detection alone are relied upon then a country would have no other choice but to ignore its suspicions or denounce the treaty.

PROPOSAL ABSTRACT B54(G79)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities

2. Verification Type:
   On-site inspection - selective

3. Source:
   United Kingdom. "Visit to Britain by chemical weapons experts (14-16 March 1979)". CD/15, 24 April 1979.
   See also: CD/PV.29, 24 April 1979.

4. Summary:
   The UK working paper is a brief summary of a visit by the representatives of several governments to two sites in Great Britain: a former nerve agent plant that is in the process of demolition and a civil chemical factory. The paper gives some conclusions based on British experience regarding the tasks and problems which must be faced in demolition of a CW plant.

   One of the conclusions reached is that on-site inspection of the type demonstrated in the UK visit can establish that a plant has been removed and that equipment has been destroyed. It can also show that a facility has been completely immobilized through removal or dismantling of the essential ancillary elements of a toxic plant, namely the means for totally enclosing the plant and the systems for ventilating the exhaust air through cleaning/detoxification equipment.

PROPOSAL ABSTRACT B55(G79)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production

2. Verification Type:
   a) On-site inspection - selective
   b) International exchange of information

3. Source:
   France. CD/PV.43, 19 July 1979.

4. Summary:

In outlining the preliminary views of France on a CW convention, the French delegate stated that the treaty should require each signatory to furnish a detailed qualitative and quantitative inventory of toxic substances and a provisional time-table for their destruction. A similar detailed inventory should be required for the destruction or conversion of CW production plants.

For France, verification is a crucial aspect of the convention though it raises the most difficult question. It is indispensable that verification be of an international character.

On-site verification of chemical disarmament is technically feasible and should be employed to ensure the observance of the production ban on specifically military agents and munitions, the observance of destruction timetables, and the control of the products of laboratories still authorized to conduct research for passive CW protection.

Verification of precursors and verification of dual-purpose substances are difficult problems substantially different from verification of substances specifically for military use. An answer to this problem has been found within the Arms Control Agency of the Western European Union which might serve as a precedent.

B5F(A80)

PROPOSAL ABSTRACT B56(A80)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks

2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors

3. Source:
   Ooms, A.J.J. "Verification of the destruction of stockpiles of chemical weapons". In Stockholm International Peace Research Institute, Chemical Weapons: Destruction and Conversion, pp. 123-128. London: Taylor and Francis, 1980.

4. Summary:

There are three components to verifying the destruction of CW agent stockpiles:

1) the size of the stockpile,
2) the percentage of stockpile to be destroyed and the rate of destruction, and
3) the possibility of confirming the rate of destruction.

The answer to problem 1 can only be gathered by intelligence work - satellite observation, estimates of the size of the chemical industry of a state, etc. If, as is likely, the stockpile is probably distributed over a small number of well-protected sites as are tactical nuclear weapons, a reasonable guess of at least the order of magnitude of the stockpile can be made.

As for the second problem, the more closely the quantities of the stockpile destroyed approach the total estimated size of the stockpile, the higher will be confidence that the stocks are being destroyed.

The third issue is crucial. Destruction carried out at multinational regional destruction sites is the most easily verifiable. On-site inspection at mutual destruction sites may generate a great deal of confidence. Great care will need to be taken to safeguard military and industrial secrets but several examples of existing safeguards procedures show that this problem is not insurmountable.

B57(A80)

PROPOSAL ABSTRACT B57(A80)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities

2. Verification Type:
   a) On-site inspection - selective
      - obligatory
   b) Remote sensors - satellite
   c) Short-range sensors - monitoring devices
      - sampling
      - seals

3. Source:
   Roberts, R.E. "Verification problems - monitoring of conversion and destruction of chemical-warfare agent plant". In Stockholm International Peace Research Institute, Chemical Weapons: Destruction and Conversion, pp. 129-138. London: Taylor and Francis, 1980.

4. Summary:
   The author believes that verification provisions are needed because of the absence of mutual trust between nations. Verification procedures can provide a vehicle for increasing this trust.

   The discussion assumes that existing CW plants will be declared as part of a treaty which bans production. It examines several possible destruction and conversion scenarios.

   Conversion Situation:

   a) Dual-purpose agents: The problem here is to distinguish between military and civilian production. An absolute answer can only be provided by monitoring production, transportation and consumption which involves detailed reporting of activities and on-site access.
   b) Single-purpose agents: Facilities which produce this category of CW agent could be readily employed to manufacture civilian products and just as readily re-employed to produce CW agents. The most likely civilian products produced by converted CW agent plants are plasticizers and pesticides. Because of the ease of reconversion stringent verification would be needed including frequent on-site inspections. During the initial inspection it would be important to determine if conversion was actually taking place or whether a parallel production stream was being installed. The inspectors, through a review of blueprints and other documentation plus actual physical inspection of the plant, would determine the time required to reconvert the facility to produce CW agents which would in turn determine the frequency of follow-on visits. This frequency would probably be measured in days or, at best, a week or so. The high level of instrusion necessary for verification and the limited economic

incentive for conversion suggest that shut-down of the plant would be a preferable alternative.

Destruction:

The following discussion focusses on two verification issues - confirming that declared plants are in fact producing CW agents and verifying the plants inactivity once deactivated. Guidelines employed in developing the following procedures were that they should be as simple and non-intrusive as is consistent with verification requirements.

1. Determining whether a declared facility was designed for CW agent production:

   Assuming the plant is inactive, it is necessary to look for the presence of:

   a) necessary chemical processing units,
   b) appropriate safety features, and
   c) special waste-treatment equipment.

   These determinations require on-site access by a specially prepared chemical processing engineer. If no documentation about the plant's processes is provided, a skilled inspector could determine that a highly toxic material was being produced but not the particular substance. If such documentation is given, then the particular agent could be specified with high reliability. No elaborate verification equipment is required. The length of time the inspector is on the site would vary from perhaps a week (when no documentation is provided) to half that time (when documentation is provided).

2. Determining whether a facility had in fact been used to produce CW agents:

   In addition to the steps outlined in the foregoing section, evidence of the agent or its degradation products must be obtained by collecting samples from the site and analyzing them. To avoid the possibility of "seeding" to give a false finding, samples should be obtained from a number of points within the perimeter of the plant. No elaborate equipment is needed for taking or transporting the samples, but the chemical analysis would require sophisticated equipment.

3. Determining that the facility has been dismantled and cannot readily be reassembled:

   Verification here is two step - confirming that the dismantling is sufficient to prevent reassembly in a short time, and continued monitoring to ensure reassembly does not occur. Generally, the greater the dismantling, the less frequent and intrusive the continued monitoring need be. On-site inspection, however, is required to assess the reversibility of the dismantling. For extensive dismantling, it is possible that the continued monitoring could be carried out by satellite together with provision for on-site visits on a challenge basis. In the case of less extensive dismantling which might permit reactivation in a period of weeks, satellite observation should be augmented by the installation of tamper-indicating seals on critical equipment in the plant. Temperature-sensitive monitors, seismic devices and pre-programmed cameras could also be used. Readings from these sensors could be transmitted via existing communications satellites or obtained during periodic maintenance visits by inspectors to the plants. Such visits would occur every four to six months.

The intrusiveness of the continued monitoring could be reduced by permitting inspectors to suggest further dismantling steps. Such an approach would require two initial site visits - one to check the degree of dismantling and to recommend other measures and the other to check that recommended steps had been taken. After that satellite observation would suffice to ensure the plant was not reassembled.

4. Confirming that a CW plant had been moth-balled and cannot be reactivated clandestinely:

The verification procedure is essentially the same as for the previous situation except that, since the plant is being preserved intact, the time required to reactivate it is inherently shorter. Two initial visits would be needed - the first to assess the state of moth-balling and to determine what on-site sensors are needed and their location; the second to install the sensors. The combined duration of these two visits could range from two weeks to a month since there will be a detailed engineering analysis and construction effort involved.

Satellite observation is moderately adequate for the continued monitoring phase but two factors argue against remote monitoring. First, maintaining the plant in a stand-by condition requires that some of the equipment be operated periodically to prevent deterioration. Second, since continued maintenance of the plant is necessary, it becomes difficult to differentiate from a distance between maintenance activities and a clandestine production run.

The type of sensors and their maintenance requirements would be similar to those for the preceding section, as would be the need for some on-site inspection by challenge procedure.

PROPOSAL ABSTRACT B58(G81)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - research and development
   - stockpiling

2. Verification Type:
   a) On-site inspection - selective
   - sampling
   b) Complaints procedure - consultative committee
   c) National self-supervision
   d) International control organization
   e) International exchange of information
   f) Short-range sensors - sampling
   g) Remote sensors - satellite
   - sampling

3. Source:
   Canada. "Verification and control requirements for a chemical arms control treaty based on an analysis of activities". CD/167, 26 March 1981.

4. Summary:
   The Canadian paper attempts to review the technical verification requirements for each basic activity to be included in a CW treaty in the hope that this will ensure that technical verification difficulties will not stand in the way of agreement.
   1. Declarations of existing CW production facilities: Remote sensors such as satellites available to the superpowers might provide confirmation of such declarations. To provide minimum confirmation to all nations some on-site visits would be necessary. Both national and international personnel (non-technical) would be used. One declared site could be inspected at random though visits to all declared sites would be desirable. Sensitive site or process information would not be revealed.
   2. Declarations of existing CW stocks: Verification requirements would be the same as for declared production sites. Deliberate non-declaration of sites (production or stockpiles) could not be detected by any technical methods including inspection though "national technical means" might reveal some cover-ups which would then require a challenge mechanism.
   3. Dismantling production facilities: It may be possible to observe dismantling by satellite but not with other remote sensors. Satisfactory international verification can only be achieved by on-site visits. At a minimum one site could be inspected at random by a combined national and international (non-technical)

team at the end of the five year destruction period. Inspection once a year would be more desirable but not essential. No chemical sampling would be needed.

4. Destruction of stocks: One approach would be "non-verification" perhaps involving invited inspection by international personnel. If this was unacceptable more intrusive verification would be needed. Monitoring of the process must be virtually continuous with periodic spot sampling and analysis by inspection teams which would include some international personnel.
5. Development of CWs: Atmospheric testing could be detected by remote means but the use of remote detection by an international body would be tantamount to an accusation and would be very expensive. The only feasible international activities would be in response to challenge mechanisms. National control agencies would do the routine monitoring.
6. Construction or conversion of new production facilities: These may be monitored by the national control bodies but routine international verification is not feasible. It would be used only in response to challenge mechanisms.
7. Production of CWs: This is a key problem. Routine monitoring of chemical plants in all nations including inspections might be feasible for national control agencies, but would be beyond the capabilities of an international agency without a large number of inspectors. Satisfactory minimum international assurance might be provided by a structured information exchange and response to challenge mechanisms. On-site challenge inspections would require chemical sampling. Routine inspections and reporting would be conducted by national control bodies.
8. Retention of stocks: International measures are limited to challenge mechanisms.
9. Offensive military training: International monitoring is limited to informal exchanges and responses to challenges.
10. Use of CWs: Reports of CW use would be carefully weighed by the international community and, if found substantial, the nation involved would be requested to allow the taking of samples from the site by international inspectors within 48 hours of an event.

Each signatory of the treaty would be required to maintain a national verification group either as a separate body or as part of an existing government agency. It would be responsible for all routine monitoring required by the agreement and for providing data to the international control body. It would also make arrangements for all on-site inspections and chemical sampling.

The international verification measures would not involve a level of employment requiring a permanent staff in any international agency. Each party could nominate one technical and non-technical inspector for use on a stand-by basis. The international verification agency need only consist of a supervisory (consultative) committee at a political level which would meet periodically or on request, supported by a small secretariat. The committee would determine the verification measures to be undertaken while the secretariat would provide for routine measures.

Much of the verification emphasis will be placed on challenge mechanisms and these must be specified in detail in the treaty.

PROPOSAL ABSTRACT B59(A62)

1. Arms Control Problem:
   Conventional weapons

2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - aerial
   c) International control organization

3. Source:
   Etzioni, A. The Hard Way to Peace: A New Strategy. New York: Collier, 1962.

4. Summary:
   This proposal suggest that military bases, especially if they are located in third countries should be opened to on-site inspection by any country and that an international disarmament organization conduct inspections periodically as well.
   Aerial surveillance would be carried out to verify the demolition of bases.

PROPOSAL ABSTRACT B60(A62)

1. Arms Control Problem:
   Regional arms control - nuclear weapons free zones
   - Africa
   - Near East

2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - aerial
   c) International control organization

3. Source:
   Frisch, D. "A Proposal for an African and Near Eastern Zone Free from Weapons of Mass Destruction". In Woods Hole Summer Study, Verification and Response in Disarmament Agreements, Annex Volume I, Appendix F, pp. 71-74. Washington, D.C.: Institute for Defense Analysis, November 1962.

4. Summary:
   This proposal envisages a verification system that would include the establishment of an international disarmament organization. This organization would:
   a) inspect cargoes at seaports and airports in the zone and on overland routes into the zone;
   b) annually make a limited number of other optimal ground inspections and aerial inspections of each large country and each group of small countries.

B61(A63)

PROPOSAL ABSTRACT B61(A63)

1. Arms Control Problem:
   Regional arms control - nuclear weapons free zones

2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - satellite

3. Source:
   Wheeler, G.J. "Inspection in a Nuclear Free Zone". In Weapons Management in World Politics: Proceedings of the International Arms Control Symposium December 17-20, 1962, pp. 491-499. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:

This proposal suggests a verification system that could be applied to the establishment of nuclear free zones in regions containing no previous nuclear stockpiles. This, the author maintains, simplifies the matter of verification considerably. There is no need to search for missile launching sites or banned-weapon production facilities, nor is there a stockpile problem since these things are known for certain beforehand. The verification system proposed here would use normal diplomatic and tourist sources of information to monitor compliance with an agreement establishing a nuclear weapons free zone. The author maintains that it is precisely these sources that have allowed us to know that certain regions are free of nuclear weapons and that these sources can continue to offer assurance of compliance with an agreement. "Ambassadors, consuls and their staffs would be aware of suspicious circumstances by the very nature of their duties. Countries generally welcome tourists who travel freely and thus could inspect if they chose" (p. 489). New restrictions, for instance, on travel might lead to suspicion and the government concerned could be questioned as to the reason for the new restrictions. Similarly, large numbers of natives visiting a foreign nuclear power for training in new technologies might raise questions. A large influx of foreign nationals to man new equipment would also be suspicious. The author assumes that even clandestine activities would offer opportunities for detection; for instance, an increase in the number of planes or ships arriving in a country.

An operating inspection system would be called on to investigate suspicious activities. This might include satellite monitoring initially and, if necessary, on-site inspection later on. In this way, a relatively few inspectors would be required to monitor the suggested agreement.

Finally, the author suggests that an agreement among the non-nuclear nations must not preclude uses of atomic energy, but that international safeguards should be applied in such cases.

PROPOSAL ABSTRACT B62(T67)

1. Arms Control Problem:
   a) Regional arms control - nuclear weapons free zones
   b) Nuclear weapons - proliferation
   - peaceful nuclear explosions

2. Verification Type:
   a) On-site inspection - selective
   - obligatory (Article 16)
   - IAEA safeguards (Article 12)
   b) Complaints procedure - referral to new international body (OPANAL, Article 16)
   - referral to Security Council
   - referral to General Assembly
   - referral to Organization of American States
   c) International control organization

3. Source:
   Treaty for the Prohibition of Nuclear Weapons in Latin America. (The Treaty of Tlatelolco)
   Signed: 14 February 1967*
   Number of parties as of 31 December 1979:
   -to Treaty: 22
   -to Protocol I: 2
   -to Protocol II: 5

4. Summary:
   The scope of the verification system is defined in Article 12 (2) and includes verifying:
   a) that peaceful nuclear services and equipment are not used to test weapons,
   b) that no activity prohibited under the Treaty (Article 1) occurs using nuclear weapons from outside the zone, and
   c) that PNEs are conducted according to Article 18.
   To achieve these ends the Treaty calls for the application of IAEA safeguards to each state party's nuclear activities

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* The treaty enters into force for each state that has ratified it when the requirements specified in the treaty have been met (i.e. when all states in the region when the treaty was opened for signature ratify it, when nuclear weapons states have ratified Protocols 1 and 2; and when safeguards agreements are concluded with the IAEA), unless the party ratifying the Treaty issues a waiver of these conditions.

B62(T57)

(Article 13). Under Article 14, states parties are required to submit semi-annual reports to the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL) and to the IAEA, concerning nuclear activity on their territory. Any other reports made to the IAEA are also to be sent to OPANAL. Provision is made as well for transmission of reports to the Organization of American States (OAS).

The Secretary-General of OPANAL can request further information from any state party under Article 15. Both the IAEA and the Council of OPANAL (through the Secretary-General) can conduct special inspections under Article 16, the latter on request of any state party. Such inspections are obligatory, and the access of inspectors to all facilities is to be full and free. Article 16 is also noteworthy because it provides a mechanism for finding undeclared facilities.

Artcile 18 provides procedures for the conducting of PNEs. Prior notification to the IAEA is required giving the date, nature of the device, place and yield. Personnel from OPANAL and the IAEA are to observe all preparations and the test itself and the observers are to have unrestricted access to the test area.

Complaints can be lodged with OPANAL (Article 16). The General conference of OPANAL can if necessary refer the complaint to the UN Security Council or General Assembly, or to the OAS (Article 20).

PROPOSAL ABSTRACT B63(I76)

1. Arms Control:
   a) Regional arms control - nuclear weapons free zone
   b) Nuclear weapons - proliferation
2. Verification Type:
   a) On-site inspection - selective
      - IAEA safeguards
   b) Complaints procedure - consultation and cooperation
      - referral to new international body
      - referral to Security Council
      - referral to General Assembly
   c) National self-supervision
   d) International control organization
3. Source:
   Special Report of the Conference of the Committee on Disarmament. "Comprehensive study of the question of nuclear weapons free zones in all its aspects", A/10027/Add. 1, 1976. See especially Chapter 5 "Verification and Control", pp. 43-47.
4. Summary:

The Special Report describes the general requirements for NWFZ agreements. The following is a summary of the report's discussion on verification and control systems.

The precise nature of the verification and control system will vary with the region and type of obligations incorporated into the agreement. The system should include provisions for verifying compliance and provisions for settlement of disputes. It should also include fact-finding machinery, a procedure for consultations between states and a forum for multilateral consultations.

There are two tasks regarding verification of an NWFZ agreement. One is to ensure that zonal states do not develop or produce nuclear weapons. The other is to ensure that the zone is free of nuclear weapons introduced from outside sources.

The first verification task can be achieved through the application of IAEA safeguards to all nuclear material in zonal states. It is preferable that all nuclear activities, not merely particular ones, be subject to the safeguards. Furthermore, present IAEA safeguards only monitor declared nuclear acitivites, hence it must be ensured that all nuclear activities in the zone have in fact been declared to the IAEA.

The second verification task would be undertaken by machinery additional to the IAEA. This body's duties may include inspection of military installations, naval vessels and military aircraft within the zone. Existing regional or international organizations might undertake these responsibilities, otherwise it might be preferable to establish standing regional bodies to implement

those verification procedures not falling to the IAEA. One of the functions of such a regional body would be to monitor and coordinate the work of the national authorities responsible for verification within each state. Reciprocal investigation and inspection either directly or through the standing regional body and detailed consultation procedures would be important for settling disputes. A multilateral body would have the task of considering the reports of the standing control agency. It would also consider disputes over possible non-compliance when consultations between parties had failed. However, the parties should continue to have the right to refer complaints to the Security Council, General Assembly or other international body.

It is also desirable that one element of the verification system be a provision requiring states in a zone to apply adequate standards of physical protection to the nuclear material in order to prevent theft.

Inspections would be an integral part of the IAEA element of the system. A standing control agency could also have the power to carry out both routine and *ad hoc* inspections concerning obligations not verified by the IAEA.

It might be desired in some regions to assign all verification responsibilities to a special organ of the IAEA. This however would require amendment to the IAEA statute. On the other hand creation of *ad hoc* agencies might be useful for organizing the execution of the overall verification system.

PROPOSAL ABSTRACT B64(A77)

1. Arms Control Problem:
   Regional arms control - outer space
2. Verification Type:
   a) On-site inspection - selective
   b) Remote sensors - satellite.
3. Source:
   Frye, Alton. "Strategic Restraint, Mutual and Assured". *Foreign Policy* 27 (Summer 1977): 3-24.
4. Summary:
   In order to supplement provisions in SALT I banning interference with NTMs, Frye suggests a flat prohibition on development and testing of anti-satellite weapons. Close approach by one country's satellite

to that of another should be prohibited unless there is prior notification and full description of the approaching satellite's mission and capabilities.

Equally important is a ban on high-energy laser and particle-beam tests in outer space and a ban on large nuclear reactors or other power sources in space capable of generating threatening levels of laser or particle-beam output.

To ensure that satellites conform to the proposed rules, the parties should arrange joint visits to space stations and other man-made objects orbiting the earth, perhaps in the space shuttle. Non-destructive external inspections would be permitted during the joint visits. Where satellites are inaccessible to visits by joint crews, procedures should be drawn up for remote inspection on an agreed schedule by unmanned satellites.

PROPOSAL ABSTRACT B65(A62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   On-site inspection - selective

3. Source:
   Etzioni, A. The Hard Way to Peace: A New Strategy. New York: Collier, 1962.

4. Summary:
   This proposal seeks a solution to the problem of intrusiveness in dealing with armament reductions. It is suggested that weapons to be destroyed should be moved under international supervision to a place outside the boundaries of the nation to whom they belong and destroyed there under international supervision.

   As the process of disarmament proceeds, and confidence increases, it might be possible to transfer, under strict controls, certain weapons (i.e. ships, planes, radars) to neutral states where they could be conver[illegible]d for peaceful purposes. In any case, whether the weapon system is to be converted or destroyed, free inspection of it would be permitted at the destruction site so as to diminish the value of the weapon to its original developer.

B66(A58)
B67(A58)

PROPOSAL ABSTRACT B66(A58)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   On-site inspection - selective

3. Source:
   Derman, Cyrus and Morton Klein. "On the Feasibility of Using a Multiple Linear Regression Model for Verifying a Declared Inventory". In Inspection for Disarmament, pp. 220-224. Edited by Seymour Melman. New York: Columbia University Press, 1958.

4. Summary:
   This paper reports the results of an experiment which attempted to estimate past production of a plant on the basis of an analysis of current relations between several inputs and output. If this could be done accurately then the past (estimated) output of a plant could be used as a check on the accuracy of a declared inventory.

   On the basis of 13 weeks observations at a manufacturing plant, the results using a multiple linear regression model indicated that the approach was inadequate for verifying the accuracy of declarations. At best, a different and probably more extensive analysis of the current production system is required. Given even a small error factor, if systematic caching of output was practiced continually (including during the period of observation) then the model would not be effective.

PROPOSAL ABSTRACT B67(A58)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   On-site inspection - selective
   - sampling

3. Source:
   Solomon, Herbert. "The Use of Sampling in Disarmament Inspection". In Inspection for Disarmament, pp. 225-230. Edited by Seymour Melman. New York: Columbia University Press, 1958.

4. Summary:
   In many disarmament situations, to inspect all factories, laboratories or government records would involve large numbers

of staff and high costs. Moreover, it may be impossible to recruit enough trained personnel. One way of reducing the number of personnel needed and the costs is through sampling. This paper attempts to assess some sampling designs for inspection purposes. Two inspection targets are used for illustrative purposes: metal-working plants and biological laboratories.

By dividing the inspection targets into groups of high, moderate and low chances of evasion and by applying stratified sampling theory, the author derives tables relating costs to optimum sample sizes for the three groups. When evasion is practiced in some plants but not others there will be a risk of not detecting the evasion. This can be reduced by increasing the sample size.

PROPOSAL ABSTRACT B68(A61)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   On-site inspection - selective
   \- non-obligatory

3. Source:
   Schelling, T.C., and M.H. Halperin. Strategy and Arms Control. New York: Twentieth Century Fund, 1961.

4. Summary:
   This proposal assumes that each party to an arms control agreement complies with the provisions of the agreement and wishes the other parties to know that it is complying. On this basis, each country would be motivated to provide sufficient evidence of its compliance, not just to submit to agreed examination.

   The authors suggest that it would be the responsibility of each country to demonstrate compliance in any way it can, by inviting examination and extending such facilities as would leave no reasonable doubt as to its fulfillment of its obligations.

PROPOSAL ABSTRACT B69(A65)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   On-site inspection - selective
   - sampling

3. Source:
   The Application of Statistical Methodology to Arms Control and Disarmament: Final Report. Report submitted to United States Arms Control and Disarmament Agency. Princeton, New Jersey: Mathematica, September 1965.

4. Summary:

The aim of the research reported in this work is the identification and exploration of potential applications of statistical methodology to arms control and disarmament. Ten papers form the bulk of the report:

1) "Principles of Sampling as Applied to a Disarmament Agreement". Enumerates arms control and disarmament proposals which lend themselves to sampling techniques and discusses problems which may arise. Several techniques to ameliorate some of these problems are presented including hierarchical, cluster and stratified sampling.
2) "Statistical Methods in Arms Control: Some General Considerations". Surveys potential uses of statistical techniques in surveillance and the enforcement of a disarmament treaty, specifically concerning the collection of data, the evaluation of data and the design of stabilization measures.
3) "A Multistage Inspection System for a Disarmament Treaty". Outlines an inspection system which minimizes the amount of intrusion while maintaining an acceptable level of security. The central idea is to allow the inspected party to control the amount of inspection beyond some specified minimum.
4) "Record Consistency as a Criterion of Compliance with an Arms Control Agreement". Explores the key concept of any records inspection verification system, namely the consistency of records.
5) "Description of Record and Material Flow in a Simple Factory". Discusses verification in the context of a simplified production process.
6) "On Evaluating Inspection Plans for Policing a Disarmament Treaty"
7) "Some Extensions of the Theory of Recursive Inspection Games". Both this paper and the former one (6) present new models for the allocation of effort in an inspection system with a limited quota of inspections.
8) "Toward an Adequate Disarmament Game". Deals with the methodological problems encountered in the use of gaming models for the design and operation of an arms control verification apparatus.

9) "The Inspector's Non-Constant-Sum Game: Its Dependence on One Detector". Constructs and analyzes a model which might be used to enforce a test-ban treaty.
10) "The Inspector's Non-Constant-Sum Game: Its Dependence on a System of Detectors". Considers a model involving a set of detectors instead of one.

PROPOSAL ABSTRACT B70(A68)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   On-site inspection - selective
   \- sampling

3. Source:
   Feld, B.T. "Problems of Inspection and Control of Disarmament Agreements" (a Pugwash lecture, August 1968). In *A Voice Crying in the Wilderness: Essays on the Problems of Science and World Affairs By Bernard T. Feld*, pp. 100-111. Oxford: Pergamon Press, 1979.

4. Summary:
   According to Feld it is not generally recognized how effective random sampling can be for detecting violations even if the sampling has a relatively small *a priori* probability of detection, provided the randomness of the sample can be assured.
   In an example of 200 missile sites randomly distributed over an area with inspections of five randomly selected sites permitted and with a probability of uncovering a given missile in a given site only 50%, the chance of a violation *not* being detected is 3%.
   Random sampling is therefore an exceedingly effective means of detecting violations. However the achievement of randomness, especially in a situation in which the inspected party is intent upon hiding its violations, is by no means a negligible problem.

PROPOSAL ABSTRACT B71(A76)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) On-site inspection - selective
   - non-obligatory

3. Source:
   Myrdal, A. The Game of Disarmament. New York: Pantheon, 1976.

4. Summary:

This proposal, often termed "verification-by-challenge" is based on the interest a country which is under suspicion of violating an arms control agreement has in freeing itself of suspicion "through the supply of relevant information, not excluding an invitation to inspection by an outside party or organ." Invitations to inspect would be forthcoming spontaneously in some instances and under pressure in more severe cases of doubt. Should such a challenge go unheeded on several occasions, other parties to the treaty would acquire the right to withdraw from it.

The threat of withdrawal might induce the accused party to offer clarification of the suspected event, or if the suspicion persisted, to invite inspection. The system of "verification-by-challenge" would be useful whether or not obligatory inspection were envisaged, in the treaty. "If obligatory inspection were envisaged, verification-by-challenge would help reduce the size of the unresolved problem and, if inspection were not envisaged, it would help resolve suspicions." (p. 301)

CHAPTER C

PROGRESSIVE/ZONAL ON-SITE INSPECTION

Progressive/zonal on-site inspection is an approach to verification that grew out of a recognition of some of the problems inherent in general and selective on-site inspection systems. Objections were consistently raised by some nations that verification of declared weapons inventories prior to the beginning of any general disarmament process would amount to legalized espionage and could lead to aggression. Other countries, on the other hand, voiced dissatisfaction with disarmament proposals which called for reductions of arms levels prior to verification of initial levels. Both groups, struggling for arms limitations or disarmament in a climate of suspicion, evidently had legitimate arguments.

Progressive/zonal on-site inspection is a method that seeks to match the level of inspection with the level of arms reductions. As such, one of its central aims is confidence building. Unlike the case of general inspection, verification is to be entered into gradually in such a way as to develop trust in the process.

Two distinct but related types of systems can be identified here, progressive and zonal. The distinction lies in the sort of progression envisaged by a given proposal. Inspection can be instituted progressively by type of facility, intensity of inspection, or area. The term "progressive" may refer to all these types while "zonal" is generally reserved for progressive area inspection. Progressive inspection by facilities could mean that certain types of facilities, such as those for missile production would be inspected before actual missile launch sites or stockpiles were inspected. Restrictions or bans on these facilities would accompany the inspection. Progressive inspection by intensity would mean that while all regions to be controlled were open from the beginning, the number of inspectors would at first be small and the scope of their activities correspondingly limited. Only as the disarmament process advanced and confidence was built up would their numbers be gradually increased to permit more comprehensive inspection.

Zonal inspection systems vary considerably. Generally they call for the division of regions to be controlled into sections which often correspond to military administration districts. A section is then selected (there are various techniques by which choices can be made) and sealed by inspectors. Once the sealing is complete, other inspectors move into the area and conduct a thorough search, either to verify the absence of banned weapons or to verify that numerical limitations on weapons are being adhered to.

Progressive/zonal inspection is frequently associated with a confrontation situation where two opposing factions are extensively deployed to defend against possible aggression from each other. By dividing the whole area of confrontation into a number of regions it becomes easier to negotiate disengagement in the less heavily militarized regions first and build up confidence in the arms reduction process without revealing major strengths or weaknesses. The method has been primarily associated with GCD.

The concept of progressive inspection represents a serious attempt to bridge the gap between the real world of conflicting goals and the ideal world of non-aggression, but it is perhaps too complex to implement to be adopted enthusiastically.

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Chemical weapons	1
General and complete disarmament	6
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PROPOSAL ABSTRACT C1(A60)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - manned aircraft

2. Verification Type:
   a) On-site inspection - progressive/zonal
   - control posts
   b) Remote sensors - aerial

3. Source:
   Kissinger, H.A. "Arms Control, Inspection and Surprise Attack". Foreign Affairs 38, no, 4 (July 1960): 557-575.

4. Summary:

Each country with nuclear weapons would designate regions where it would agree to station no retaliatory weapons, and another group of areas in which only a certain number would be permitted. The areas stripped of retaliatory weapons would be open to unlimited inspection. This would be "negative evidence" inspection, which seeks to verify the absence of retaliatory weapons.

In the regions containing retaliatory weapons, "inventory" inspection would be carried out. That is, at some agreed interval, perhaps twice a year, inspectors would have free access to determine the strength of available forces. These inspectors would be barred at all other times. During the periods of inventory, the retaliatory force would have to be stationary, and this could be monitored through an adequate combination of ground and aerial inspection. These forces could be mobile at all other times. The system would not necessarily create excessive vulnerability during inventory periods when the precise location of opposing forces is known. That is, if land-based retaliatory forces were placed in several different areas separated by territory in which uncontrolled inspection were permitted, and inventories in each area were taken at different times, the retaliatory force would continue to be mobile in some regions while it is being counted in others. Unlimited inspection in the territory separating these areas could detect the shifting of weapons from one region to another. Inspectors could be stationed at all access points to armed areas, thereby preventing substantial illegal buildups.

If armed areas were kept away from industrial areas, production of weapons could be easily and constantly monitored by inspectors in the unarmed areas.

If all ports and harbours were included in regions of unlimited inspection, a check on new construction would be achieved. An inventory on the total force could probably be obtained in this way too, since all ships must return to port at some time.

To ensure that aircraft are effectively counted and that illegal shifting of aircraft does not occur, the whole inventory process should begin with a count of all aircraft in all regions. At the beginning of the inventory, all planes would be grounded and inspection teams would move into the airfields. After the planes are counted, the inventory of missiles would proceed region by region. To prevent the airlifting of missiles out of areas where an inventory is about to take place, the inspection teams would remain at the airfields until the inventory in all regions was completed.

PROPOSAL ABSTRACT C2(A61)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
2. Verification Type:
   a) On-site inspection - progressive/zonal
   - sampling

   b) Remote sensors - aerial

   c) Records monitoring - plant
3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In *Arms Control: Issues for the Public*, pp. 127-131. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.
4. Summary:
   Assuming the existence of an agreement severely limiting the number of ballistic missiles a nation may maintain, this proposal envisages a system to verify that the specified reduction takes place and that there are no clandestine increases later.

   The control system would require each party to inform the inspecting authority of how many missiles it had manufactured, how many it was now giving up to reduce to the required levels and where the remaining missiles are located.

   In a phased program, the process of determining the veracity.

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C3(A62)

of the submitted information would be controlled. On-site inspection of production facilities and their records, interrogation of personnel engaged in missile development and production would serve to confirm the declaration of past missile production. Aerial and random ground inspection (phased, by area) would verify present levels and would help to uncover clandestine stockpiles. Sampling techniques would make 100% assurance of compliance unnecessary.

PROPOSAL ABSTRACT C3(A62)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - missile tests

2. Verification Type:
   a) On-site inspection - progressive/zonal
   - control posts
   b) Remote sensors - aerial
   c) Non-physical/psychological inspection

3. Source:
   Etzioni, A. *The Hard Way to Peace: A New Strategy*. New York: Collier, 1962.

4. Summary:

This proposal envisages an agreement that would have national territories subject to disarmament divided into two classifications, those containing nuclear weapons and those devoid of such weapons. The areas should be large enough that an adversary cannot pinpoint strategic targets like missile silos. Non-nuclear areas would then be divided into 10 zones, one of which would be disarmed and opened to on-site inspection each year. After 10 years, the whole country, excepting the nuclear areas, would have been disarmed and inspected.

The author proposes three measures that could be taken to defuse fears of the intrusiveness of this proposal. Inspectors would:

a) take vacations outside the country they are inspecting,
b) be under orders not to fraternize with nationals of the country in which they are stationed, and
c) live in isolated quarters or in large cities accustomed to foreigners.

Finally, in the opinion of the author, the monitoring of port facilities requires special measures. He proposes that inspection ships should be posted at the entrance of ports and that inspection towers equipped with searchlights be established at the centre of each harbour.

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Once non-nuclear disarmament was complete, the disarmed areas would be inspected in toto by both ground and air inspection teams to ensure that the weapons stationed in nuclear zones were not being transferred to the disarmed zones. As soon as this is done, each party to the agreement possessing nuclear weapons would declare its inventory of nuclear weapons and delivery systems and would install consistent serial numbers on all weapons. Compliance with the commitment to carry out the serial number procedure would be verified initially by national intelligence means and by "citizen supervision". The author suggests that it would be desirable for inspected nations to permit random checks of the serialization by other countries. Violation of the serialization commitment would be considered a serious infraction of the agreement. Once the inventory was validated, weapons would be destroyed on a neutral territory, or converted to peaceful uses by the United Nations. The accompanying ban on missile tests would be monitored from stations outside the country and from stations located in the de-militarized zones.

The process would proceed until each country had just one zone armed with nuclear weapons. The defusing of these weapons could be deferred until such time as the parties considered these safeguards to be no longer necessary. Upon total disarmament, unlimited right of inspection would be initiated to prevent re-arming by dissenting groups.

PROPOSAL ABSTRACT C4(A65)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - manned aircraft
   - missile tests

2. Verification Type:
   a) On-site inspection - progressive/zonal
   b) International exchange of information - declarations

3. Source:
   Committee on Strategic Delivery Vehicles. Woods Hole Summer Study, 1962. "Verification of Reductions in the Number of Strategic Delivery Vehicles". In Security in Disarmament, pp. 50-68. Edited by R.J. Barnet and R.A. Falk. Princeton, New Jersey: Princeton University Press, 1965.

4. Summary:
   The focus of this proposal is on the verification of an agreement reducing the number of strategic delivery vehicles, the reductions to be phased in six month increments over

six years. The first step involves an inventory declaration of all strategic delivery vehicles as well as facilities concerned with their production and testing. During the first half of the process inspectors would observe the destruction of delivery vehicles and would inspect all declared production facilities. The number of inspectors would be limited initially and would gradually be increased as their verification duties were extended. This would serve to generate confidence in inspection as a verification technique.

The inspectorate would be allowed a limited number of inspections (say 100) per year for selected industrial facilities, in addition to continuous monitoring of declared production facilities and of test activities associated with related peaceful programs. The (100) inspections would be pre-emptive and would not require presentation of supporting evidence of suspicion. The inspection visits to industrial facilities might consist of tours through the selected facilities and interviews with plant personnel, with no monitoring of records, blueprint examination or hardware testing. A selective monitoring of activities of professional personnel, especially those presently associated with aircraft and missile programs could be undertaken.

The program would include occasional inspection of sites suspected of containing hidden stockpiles, and would cover observation of defensive measures such as air-defence, anti-missile defence and anti-submarine systems.

As a component of the system, a missile test ban might be verified by pre-launch inspections designed to reveal the purpose of each booster test and by employment of radar nets capable of detecting launchings that have not been reported.

C5(G79)

PROPOSAL ABSTRACT C5(G79)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - stockpiling

2. Verification Type:
   a) On-site inspection - progressive/zonal
   b) Complaints procedure - consultative commission
   c) International control organization

3. Source:
   Spain. CD/PV.42, 17 July 1979.
   See also: CD/PV.88, 1 July 1980.

4. Summary:

Spain in PV.42 suggests that there is a need for groups of technical experts which could provide extensive technical advice. These would be independent of any bodies of a political nature which might be established. All states should have access to that body without discrimination and there should be no regime enabling some states to block measures designed to ensure prompt verification.

In PV.88 the Spanish representative stated that any advisory committee set up in the context of a verification system would have to have wide powers. Because of the disparity in technological capabilities between states, the effectiveness of national means of verification should not be over-estimated. The main burden of verification should be borne by international means. The capabilities of an international body would be greatly enhanced if states in possession of advanced capabilities would cooperate with that body.

On-site inspections are needed, however. In this regard, a gradual process of delimiting critical zones which could be subject to on-site verification would be possible. These zones could be established initially in light of information circulated in the media and gradually extended to sectors with large-scale chemical industry complexes. This procedure could be negotiated within the framework of some international machinery that might perhaps be established.

PROPOSAL ABSTRACT C6(A62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) On-site inspection - progressive/zonal
      - control posts
   b) International control organization
   c) International exchange of information

3. Source:
   Sohn, L.B. "Territorial Arms Control: A Proposal". In Arms and Arms Control, pp. 209-218. Edited by E.W. Lefever. New York: Praeger, 1962.

4. Summary:

This proposal presupposes the establishment of continuous on-the-spot controls over certain activities or establishments, and unrestricted mobile inspection teams looking for clandestine activities in violation of the disarmament agreement. Assuming that fixed control posts would be generally acceptable, this proposal attempts to meet objections to mobile inspection by suggesting that each cut in armaments could be accompanied by the extension of mobile inspection only to a specified part of a nation's territory, proportional to the total arms reduction at each step.

At the beginning of the disarmament process, each country would submit to an International Disarmament Organization (IDO) two lists, one enumerating all facilities to be subject to constant surveillance by fixed teams, the other listing the national totals of various armaments, installations and production facilities subject to control, as well as regional totals of these. A thorough inspection of one randomly-chosen region would verify the accuracy of the lists. This initial choice of the region would be made by the IDO or by the other parties to the agreement and no prior notice would be given to the inspected country. In order to prevent last minute shifts between regions, inspection teams would be stationed on the borders between regions and at principal rail, road, and airfield centres. Once the region to be inspected has been chosen, the teams on the boundaries of the selected region would remain in place while other teams would be withdrawn from the boundaries of the unselected regions and would assist in the inspection of the selected region. Immediately after the selection, the nations concerned would submit a detailed list of armaments and other objects of control located in the selected region, the totals of which should differ significantly from the general list submitted in advance. The inspection teams

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C7(A62)

would verify the accuracy of the list and would supervise the actual process of disarmament within the region.

This process would be repeated with each new stage of the disarmament process.

PROPOSAL ABSTRACT C7(A62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) On-site inspection - progressive/zonal
   b) Remote sensors - aerial

3. Source:
   Sohn, L.B. "Zonal Disarmament and Inspection: Variations on a Theme", Bulletin of the Atomic Scientists 18, no. 7 (September 1962): 4-7.

4. Summary:
   Two variations on the theme of progressive/zonal on-site inspection are offered.
   1) The country to be inspected divides its territory into an agreed number of zones, ten for instance, and the inspectorate choses one of the zones for disarmament. There would be no need for inventories. This follows from the idea that no nation would know in advance which zone would be chosen and would therefore be likely to create its zone with an eye to distributing its military strength evenly so as not to lose too much if one zone is selected rather than another. Once a zone is chosen, the inspectors would seal its borders in order to make sure no weapons were removed from it. The inspected country would then proceed to demilitarize the zone, and only after this was done would the inspectors enter. The inspectors would check that all weapons had been destroyed and that there were no factories still producing weapons in the zone. Upon completion of these tasks, the inspectors would proceed to another zone.
   2) To verify an agreement that includes, say, a 10% reduction in all major armaments and a strict limitation on the production of new weapons, a somewhat different verification technique is proposed. Each country would

divide its territory into 10 zones for example. It would then submit to an International Disarmament Organization (IDO) a declaration stating the total level of all armaments in each zone and giving the location of facilities for production of armaments. The IDO would then verify that production of armaments had ceased, by on-site inspection where necessary. Thus only location of production facilities, not of armed forces or armaments, would be provided to the IDO. Next the IDO would select a zone for disarmament, and would be provided with a more detailed inventory of forces and arms in the zone, locations included. Arrangements would be made to ensure that movement of arms and forces did not occur between zones. Various methods of verifying this are mentioned. Inspection by both ground and aerial inspectors of all relevant objects would then proceed within the zone.

PROPOSAL ABSTRACT C8(A62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   On-site inspection - progressive/zonal

3. Source:
   Sohn, L.B. "Zonal Arms Reduction to a Minimum Deterrent". Verification and Response in Disarmament Agreements, Annex V-1. I, Appendix A, Woods Hole Summer Study, Institute for Defense Analysis, Washington, D.C., November 1962, pp. 47-50.

4. Summary:
   Proposals for a zonal approach to disarmament are usually based on either "zonal disarmament" (i.e. the total disarmament of one zone after another) or on "zonal inspection" (i.e. the progressive inspection of one zone after another, without any obligation to disarm a particular zone):

   A third approach might be possible, under which each nation would be permitted to retain a specified number of strategic weapons in each inspected zone, would destroy a specified number under international supervision, and would destroy the undeclared excess prior to the beginning of the inspection. Under this system there would be no need for an initial declaration of the total number of weapons or of the number of weapons in each zone. Nations would be safeguarded by keeping their own minimum deterrent forces (a specified number of weapons per zone) until the very end of the disarmament process.

In practice, this method might work as follows: each state would divide itself into a specified number of zones, for example, ten. As a matter of self-interest all states would probably distribute their military strength as evenly as possible among their zones in order not to lose too much if one zone rather than another were chosen for inspection and the destruction of weapons above the permitted minimum.

During the initial period of each disarmament step, the inspectors in the selected zone would have only one function: to check on the inter-zonal traffic to the extent necessary to insure that no weapons subject to destruction are being moved out of the zone. The inspected nation would be given a specified period, let us say one month, to destroy all surplus weapons in the zone; after the end of that period the inspectors would be permitted to move throughout the zone to verify the fact that only the agreed quantity of weapons needed for a minimum deterrent remained in the zone and that the remainder had been properly destroyed. All the permissible weapons would be permanently numbered by the inspectors, possibly with a special radioactive paint which cannot be duplicated, and their inspection thereafter would be limited to the checking of the number.

After the verification process is completed, another zone would be chosen and the process would be repeated. Each of the inspected zones would remain permanently subject to further inspection on a random basis in order to insure that new weapons had not been produced clandestinely. These later inspections might be limited to a certain number of inspections per year and to a specified percentage of weapons in order to avoid releasing too much information about deployment.

Upon the completion of the first phase of the disarmament process, the weapons of the two main power blocs would have been reduced to the agreed minimum deterrent, and there would have been a sufficient amount of inspection to insure that a significant number of strategic weapons had not been hidden. At the same time, this approach would avoid disclosure of any current inferiority in numbers of strategic delivery vehicles, since inspection of each zone would take place only after an unknown number of delivery vehicles in each zone had been destroyed.

PROPOSAL ABSTRACT C9(A63)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) On-site inspection - progressive/zonal
   b) Remote sensors - aerial
   c) Records monitoring - economic
   - personnel

3. Source:
   Rodberg, L.S. "Graduated Access Inspection". In *Weapons Management in World Politics: Proceedings of the International Arms Control Symposium, December 17-20, 1962*, pp. 39-144. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:
"Graduated access inspection seeks inspection procedures for detecting clandestine production and verifying levels of retained armaments which will be appropriate and acceptable at each stage of disarmament." Under this system, the access of the inspectors to the economic, political, social and military activities of the inspected nation increases with the progress of disarmament. The way in which access can be best graduated is by progressively increasing the number of inspectors, thereby increasing the intensity of the inspection. While all sizeable areas of the country would be subject to inspection from the outset of the disarmament process, the frequency and intensity with which the inspectors' rights of entry into these areas can be exercised are limited at the beginning and increase as disarmament proceeds.

The progression in which the increase in inspection would develop might be based on the sensitivity of the objects of inspection. For instance, areas presently open to foreigners might be dealt with early in the process while production facilities, military bases, etc. might come later.

Mobile ground inspection teams, aerial inspection, economic and personnel records monitoring are all suggested as integral parts of the system.

PROPOSAL ABSTRACT C10(A64)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) On-site inspection - progressive/zonal
   - selective
   - general
   b) Remote sensors - aerial
   c) International exchange of information
   d) International control organization

3. Source:
   Clark, Grenville and Louis B. Sohn. "Draft of a Treaty Establishing a World Disarmament and World Development Organization Within the Framework of the United Nations". In Current Disarmament Proposals as of March 1, 1964, pp. 61-182. New York: World Law Fund, 1964.

4. Summary:

This proposal envisages the creation of a complex scheme to implement disarmament and to maintain peace in a disarmed world. One of the elements of the proposed World Disarmament and World Development Organization would be a United Nations Disarmament Authority which in turn would contain a United Nations Inspection Service (UNIS) under a five member UN Inspection Commission. UNIS would be headed by an Inspector-General who would be responsible for the administration of the Service and recruitment of its staff.

One of the tasks of UNIS would be to verify the taking of an arms census of every nation of the world (Article 35). To do this each country will delineate ten zones of its territory as inspection areas, each containing about one tenth of all its military resources. In each six-month period of the actual disarmament process, one of these areas, chosen by the Inspection Commission, will be completely inspected by UNIS. The inspectors will verify force level information provided earlier by the countries. Each six months of the disarmament process (which lasts 5 years) nations will reduce their total forces by 10% (Article 40). At the same time that it is verifying the accuracy of the arms census information, UNIS will verify the reduction in force levels (Article 43). Once one of the zones has been inspected it will remain open to inspection at any time.

When the disarmament process has been completed UNIS will still be used to monitor compliance with restrictions on numbers and types of permitted forces and with arms production licensing requirements (Article 48). The inspection duties of UNIS will also include monitoring nuclear facilities.

UNIS inspectors will be given such freedom of access to the territory of every nation as is necessary for them to do their duties. They will be obligated not to disclose confidential information not related to disarmament (Article 50).

UNIS will verify reductions in forces by observing the disbanding of troops and the destruction of arms and facilities. It will verify the observance of the arms truce by stationing permanent inspection teams at key production facilities and by periodic inspections of other facilities. The progressive verification of the accuracy of the arms census and levels of forces will be done by sealing off each zone using control posts and then thoroughly inspecting the selected zone (Article 51).

Aerial inspection will be restricted during the disarmament process to those zones being or having been inspected. After disarmament is completed UNIS will be entitled to conduct aerial surveys giving notice (Article 54).

PROPOSAL ABSTRACT C11(A65)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   On-site inspection - progressive/zonal
   - sampling

3. Source:
   Bloomfield, L.P. and L. Henkin. "Inspection and the Problem of Access". In Security in Disarmament, pp. 107-122. Edited by R.J. Barnet and R.A. Falk. Princeton, New Jersey: Princeton University Press, 1965.

4. Summary:

This proposal suggests measures that would permit sensitive areas to remain uninspected during the early stages of disarmament. Each party to a disarmament agreement might designate restricted areas containing facilities that would be opened progressively to inspection. Access to the remainder of the country and perimeter inspection of restricted areas could be maintained in order to provide a reasonable degree of confidence that significant violations were not taking place during the early stages.

As the disarmament process proceeds, perimeter observation of the restricted areas and facilities could give way to arranged tours of these areas, then to unannounced tours and inspections of communications centres and contents of transportation carriers. Finally, detailed searches of facilities would be undertaken.

This proposal seeks to meet another problem as well, namely the verification of agreed levels of armaments. It is suggested that identification indices would be assigned to each declared armament and military unit. These might be ordinary serial numbers attached to all items. Each inspection team would have a master list of all armament numbers. The possession either of an item that did not bear a number on the master list or of two armaments bearing the same number would constitute a violation. As such, the object of inspection would be to discover undeclared armaments rather than to count declared ones. This would permit the use of sampling techniques, thereby reducing both the required number of inspections and the amount of sensitive military information disclosed.

CHAPTER D

CONTROL POSTS

Control posts frequently constitute an element in other types of inspection systems. Essentially a control post is a focal point for an inspection team. It can be fixed if the team is responsible for monitoring equipment in the neighbourhood in which it is located, or mobile if the team's function is to monitor a military formation which is itself mobile. A common proposal is to have control posts at such locations as transportation centres, airfields, railway stations, main road junctions and ports to monitor military traffic. Such monitoring, it is argued, should provide warning of impending aggression by detecting any unusual flow or concentration of military power or weapons production.

Information can be obtained at a control post by direct observation as well as with high technology sensors. To be effective, however, control posts require secure communication to an information centre so that the information collected can be properly evaluated.

Control posts appear to be mainly of use in a potential confrontation situation, i.e. where troops are deployed and maintained in some degree of readiness. The two proposals included in this chapter relate specifically to the NATO-Warsaw Pact confrontation in Europe, but the method would be equally applicable to other areas of potential hostilities, including local and limited war.

Contents of Chapter D:

Arms Control Objective	Number of Proposal Abstracts
Regional arms control	2

111(A64)

PROPOSAL ABSTRACT D1(A64)

1. Arms Control Problem:
   Regional arms control - demilitarization
   - Europe

2. Verification Type:
   On-site inspection - control posts
   - progressive/zonal

3. Source:
   Holst, J.J. "Fixed Control Posts and European Stability". Disarmament and Arms Control 2 (1964): 262-297.

4. Summary:

This proposal suggests that fixed control posts be established on the territory of the party being monitored. These posts would report to evaluation centres located within the inspecting party's territory. A fixed control post is defined in general terms by the author as a post whose area of access is limited to approximately four square miles. Such an area would cover the most important part of a harbour, a railway junction, an airfield or fixed military installations such as a rocket base, a naval base or a garrison. Further, the posts could in some cases be fixed in relation to moving coordinates; for example, military units. Posts might be deployed at divisional headquarters, and move with these, for instance. The author outlines several possible types of control post, each varying by the degree of access permitted to sensitive objects of control.

The author further proposes that the area to be controlled, Europe for example, be divided into zones. Relatively narrow zones would be established on either side of the border, which would comprise a high-tension zone. Beyond these high tension areas would be established other zones to include less sensitive territory. A third set of zones would cover the rest of the region to be controlled.

The author holds that control posts established in the border zones would be highly susceptible to false alarms. They would also be unable to detect large-scale preparations which would likely take place in the second (middle) zone. Consequently, the largest number of posts should be established in the middle zone where major military preparations would probably occur.

Any missile and bomber threat would likely come from bases contained in the third (outside) zone. Control posts at airfields and missile bases might provide a brief warning time, but as the author notes would probably be too intrusive to be acceptable. Posts in the third zone monitoring conventional

build-ups would, however, comprise an important component of the system.

The author notes that this proposal could detect rapid, large scale build-ups and could improve the ability to detect long-term build-ups. It could not provide answers to all conceivable threats nor even to some of the more probable ones (eg. local aggression, border harassment, etc.). Nevertheless, it might provide a means of reassurance in a tense situation.

D2(A65)

PROPOSAL ABSTRACT D2(A65)

1. Arms Control Problem:
   Regional arms control - demilitarization
   - Europe

2. Verification Type:
   On-site inspection - control posts

3. Source:
   Windsor, P. "Observation Posts". In First Steps to Disarmament, pp. 85-99. Edited by D.E. Luard. London: Thames and Hudson, 1965.

4. Summary:

This proposal calls for the establishment of static inspection teams (control posts), stationed at three kinds of communications centres in Europe:

1) airfield capable of handling heavy transports,
2) main roads, and
3) railways

In Western Europe, roads, highways and airfields would be of special interest while in Eastern Europe, railroads and airfields would be more important. The posts would be manned by members of the opposing Alliance who would be in constant communication with their respective headquarters.

This system would not necessarily provide better information about general movements and standards of the opposing forces and their equipment than is already afforded by intelligence sources. Rather, its purpose would be "to establish norms of military activity". Warning of attack would come from notice of long-term preparations and large-scale build-ups of troops and equipment. It would give notice of rising tensions and might thereby reduce the risk of miscalculations. Furthermore, it could create a climate conducive to later reduction of armaments and troop levels and perhaps eventually to demilitarization of the zone.

It is suggested that initially the control posts could be located between the Rhine River and the Polish/Soviet border, the zone to be extended at a later date.

CHAPTER E

RECORDS MONITORING

Records monitoring has been suggested as an acceptable alternative to monitoring or inspecting actual events and processes. While it is accepted that records may suffer from sins of omission, inaccurate reporting or deliberate falsification, there is a belief that the country performing the activities needs accurate records for its own purposes and if it would make these records available to other countries they would be able to form a reasonable picture of the extent and objective of those activities. A variety of records have been suggested as suitable for this purpose. Three basic types can be distinguished:

A) economic records,
B) plant records and
C) personnel records.

A. Economic Records Monitoring

This technique, which is most frequently discussed in the context of a ban on CW production, can be distinguished from plant records monitoring mainly by its focus on general production processes, on an industry-wide level. It involves collecting and analyzing economic data on production, consumption, and trade of either:

a) certain critical or unique substances necessary to the production of a weapon; or
b) all intermediates necessary for production when a unique component cannot be found.

The objective is to detect any changes or inconsistencies in the production processes which may indicate a violation of an obligation assumed under an arms control agreement.

The technique can focus on two types of data. It can involve analysis of data acquired from existing sources of information published openly by national governments, in which case, it is tantamount to a literature survey. Or it can involve analysis of data received under an international exchange of information deliberately undertaken to provide data for verification purposes. A third possibility is, of course, some combination of these two approaches.

The use of information from open sources may involve problems since the quality and credibility of the data can vary from country to country. Many states may simply lack the capacity to generate accurate and dependable data of use for verification. Some states may have inhibitions about disclosing a great deal of information, hence any they do publish may be scant and undetailed. Other governments may deliberately falsify published information for motives of their own.

Furthermore, it is probable that there exists no standardized approach to measuring the economic activities concerned. Almost certainly methods of reporting statistics and other information will vary considerably between countries, especially in the scope and detail of the data.

Assuming that the above problems are worked out, economic records monitoring must still face its ultimate test - how effective it is in detecting violations. Here three problems must be considered. First, there is an important problem regarding the time lag involved in using the technique. Collecting and organizing data of this nature takes considerable time. Consequently, the reporting of the data will lag behind the occurrence of the events which it is intended to detect. In addition, there will be further delay as this published data is analyzed. It is not unlikely therefore that the overall time lag could amount to two or three years. This is a serious problem since the speed of detection can be crucial to the credibility of the deterrence provided by a verification technique. Compounding the problem of delay even further is length of time necessary to build a counter capability to that of the violator.

Second, economic records monitoring may simply be too insensitive to detect any but the most massive violations because of the nature of the data which is involved. It should be pointed out, however, when weighing this problem that relatively small violations may have little negative effect on the national security of innocent parties. This reasoning, unfortunately, comes up against the threat posed by deliberate prolonged evasion. Because of the technique's insensitivity, particularly when large amounts of substances are being monitored, a violator could, with reasonable confidence of avoiding detection, merely protract his diversion of substances over a long period of time.

A third problem concerns the magnitude of the task alotted records monitoring. It is clear that large amounts of data will have to be analyzed and a complex model developed for interpreting this information. Neither may be easily accomplished. Consequently, considerable investment in terms of money, manpower and other resources may be needed.

B. Plant Records Monitoring

This technique has been suggested most frequently in the context of a CW production ban and has been incorporated into the IAEA safeguards system for monitoring nuclear materials.

Unlike the more general economic records monitoring, this technique almost by definition involves some intrusion into the affairs of the country or company concerned since it would be very difficult to restrict information gathering solely to the point at issue. In theory plant accounting and operating records might be exchanged on request so that on-site inspection would not be necessary, but in practice some countries would prefer to have some confirmation of the credibility of the data by inspection. It should be noted that the existing IAEA safeguard system uses inspectors to ensure the credibility of plant records.

A further problem is the possibility that commercial and perhaps military secrets about technical processes and industrial capabilities might be gained from detailed analysis of the records provided. It should be possible to overcome this, as appears to have been done with regard to IAEA activities, but the possibility may make some countries reluctant to accept records monitoring. Plant records monitoring could be undertaken by individual participating countries or it could be assigned to an international body like the IAEA.

C. Personnel Records Monitoring

Monitoring of the whereabouts of personnel associated with weapons research and production may provide valuable information regarding the status of weapons programs. The idea is simple: if one can ascertain the location and assignment of experts in various fields, it becomes possible to verify that restricted programs have been halted. If very accurate account can be kept of personnel, it should even be possible to detect clandestine weapons production.

Various methods exist for gathering the relevant information. Voluntary declarations regarding personnel constitutes the most direct and perhaps the least reliable method. Of course, as long as declarations can be cross-checked with information gathered from other sources this method could be effective. Sampling techniques, perhaps using interviews or random telephone calls, may offer an effective means of verifying the veracity of declarations. Checks may be conducted periodically or on a once-only basis. The former is probably a superior method.

It is evident that personnel monitoring can be employed in verifying both bilateral and multilateral arms control agreements. In the latter case, international control over the personnel monitoring system would be indicated, while in the former case, either national or international control would be possible. National control would amount to a trade of data. Presumably means of verifying the veracity of declarations would be established in either case.

A further issue relates to the human rights of the personnel involved. A requirement that they should continuously account for all their daily activities could well be regarded as an invasion of privacy.

Contents of Chapter E:

Arms Control Objective	Number of Proposal Abstracts
Chemical weapons	6
Any arms control agreement	3
	9

E1(G70)

PROPOSAL ABSTRACT E1(G70)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   Records monitoring - economic
   - plant

3. Source:
   Japan. "Working paper on the question of verification in connection with the prohibition of chemical and biological weapons". CCD/288, 20 April 1970.
   See also: - "Working paper on the question of the prohibition of chemical weapons". CCD/301, 8 August 1970.
   - "Working paper containing remarks of Professor Shunishi Yamada, the University of Tokyo, concerning the question of verification on the prohibition of chemical weapons, presented at the informal meeting on 7 July 1971". CCD/344, 24 August 1971.

4. Summary:

Certain precursors of raw materials can be used both to produce CWs or non-military chemical compounds. It should be possible to determine whether these materials are being used for production of chemical weapons if one can trace the flow of such materials in each state by checking at certain points the quantities produced, imported, exported, and consumed.

In CCD/301 Japan suggests that it would be desirable to establish a reporting system for statistics of certain chemical substances preferably on a factory level. Such data could be used to support a complaint. It would, however, be impractical to report on all chemical substances, therefore it has been suggested that a lethal dose criteria be used to determine what substances should be considered. Amongst this group of substances those like nerve gases with no peaceful uses would be totally banned and hence need not be reported. Seven substances are listed that are intermediates in the production of both nerve agents and non-military organophosphorus compounds, for which data should be reported.

In CCD/344 Japan points out that in compilation of any statistics of the above kind it would be imperative to reduce the extent of statistical error as much as possible in order to decrease the likelihood of diversions.

PROPOSAL ABSTRACT E2(G70)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   Records monitoring - economic

3. Source:
   United States. "Working paper on economic data monitoring as a means of verifying compliance with a ban on chemical weapons". CCD/311, 25 August 1970.

4. Summary:

The paper is based on research by the Arms Control and Disarmament Agency. It deals with the potential for "economic monitoring" of a ban on production and stockpiling of nerve gases, using the USA's economy as a model.

Economic monitoring would aim at identifying changes or inconsistencies in economic data series that could indicate the development of CW production capability. The analysis might proceed as follows:

First, a prohibited group of chemicals is defined. In the case of nerve gases, a common molecular structure model could be used to this end so as to reduce the number of nerve agents that must be considered from a theoretically immense number to only several thousand. About 90 component materials (raw materials and intermediates) are used to manufacture these agents. Because there is low "commonality" amongst these materials (save for elemental phosphorus, a widely used substance) the economic monitoring system would have to consider all 90 substances simulataneously.

A prospective violator could obtain the component materials for agent production by:

1) increasing its own production of the required materials,
2) diverting from existing uses or stockpiles,
3) importing, or
4) some combination of the above.

Of these, increasing one's own production or making a diversion from existing stockpiles are likely to be most attractive to a violator.

For statistical monitoring to be of use, the pattern of production and consumption of the materials must be "visible". Visibility is affected by the quantity of agent to be produced, the ability to provide materials from indigenous production, the complexity of the economy and the amount, quality, precision

E2(G70)
E3(G71)

and timeliness of the data supplied.

The paper points to a number of weaknesses in the method of economic monitoring and concludes that the technique could be of ancilliary use, but alone would not provide an answer to the verification problem. It might serve as a precursor, guide, support and focussing technique, but not as a substitute for direct technical on-site inspection.

PROPOSAL ABSTRACT E3(G71)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   Records monitoring - economic

3. Source:
   Italy. "Working paper on some problems concerning the prohibition of chemical weapons". CCD/335, 8 July 1971.
   See also: "Working paper on identification and classification of chemical warfare agents and on some aspects of the problem of verification". CCD/373, 29 June 1972.

4. Summary:
   Use of economic records monitoring to detect percentage variations of organophosphorus substances arising from any diversion of these substances to production of nerve gases is feasible under certain conditions. Monitoring of raw materials (i.e. phosphorus) would be possible in countries where production of phosphorus is small. The less the initial amount of raw materials available the more significant (and detectable) will be the percentage variation due to diversion. A similar pattern can be expected for intermediate substances. It is acknowledged, however, that for states where supplies of raw and intermediate materials are very large, the usefulness of percentage variation decreases. Nevertheless, the technique is still applicable to the majority of states. It would be useful as a first step in identifying signs of suspicious activity.

Employment of the technique necessitates the collection and processing by powerful computers of large amounts of statistical data for the construction of complex models. A number of models will have to be tested and improved until a definitive one is worked out.

In CCD/373, Italy elaborates on these ideas. It defines two types of chemical agents to be banned - single purpose and dual purpose agents. The former, in most cases, are based on the use of "critical" raw materials, that is, materials which are abundant but whose sources are limited in number and location. Economic records monitoring of production of these single purpose agents would be easier "as the proportions of raw materials required for military use are greater than the average amounts used for civilian purposes in a given state, if that state were to decide to build up a militarily useful chemical stockpile". Accordingly, this type of control would be applicable at least for verification of suspected violations, in a number of states. But it would be useless in states which are major producers and consumers of such raw materials.

Verification of dual purpose agents would be easier. If a state wishes to build a military arsenal from such substances it would have to divert large amounts of them which would have a significant impact on the average amount produced for large scale civilian use. Under these circumstances, economic monitoring would be simpler. But the industrial and economic data would have to be sufficiently ample and "analytical" to reveal meaningful deviations from either the average or forecast indices.

PROPOSAL ABSTRACT E4(A73)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) Records monitoring - economic
      - plant
   b) National self-supervision
   c) On-site inspection - selective
   d) Short-range sensors - sampling
      - seals
      - monitoring devices

3. Source:
   Stockholm International Peace Research Institute. Chemical Disarmament: Some Problems of Verification. Stockholm: Almqvist & Wiksell, 1973, pp. 24-25, and 31-32.

4. Summary:

This proposal calls for broad rights of on-site inspection of chemical production facilities. The most useful method appears to be visits to chemical plants by inspectors from a national control organ, to become acquainted with all the products which are being produced, in all stages of the production process. Differentiation between chemical agents produced for warfare and those produced for peaceful uses is possible by studying the safety measures applied in the factory.

The proposal suggests that before deciding to visit a plant, analyses of the contents of possible additives in waste waters, waste gases and in the soil around the plant building should be undertaken. Where the presence of suspect compounds was established, an inspection of the plant concerned would be indicated. The proposal suggests, further, that upon implementation of a ban on the production of militarily significant chemical agents, national control agencies should verify the closure of the plants concerned and their conversion to the production of compounds for peaceful uses.

In the case of dual-purpose products, the verification system would deal primarily with statistical accounting of production and consumption. Accounting for the derivative products of certain chemical processes would be especially useful. Inspection of plant records and becoming acquainted with the processes of the plant would provide added assurance as to the accuracy of all relevant data.

It is further suggested that in cases where on-site inspection of individual enterprises is not feasible, remote monitoring devices, sealed and accessible only to those authorized by the national control agency, should be employed.

It is also recommended that an analysis of the statistical data accumulated to verify the ban on production of CW agents be made at least once a year, and in some cases, more frequently.

With regard to the national control organ, it is essential that the agency be able to fulfill its functions under the unique conditions of the country concerned. The agency must be an arm of the central government though preferably an independent body reporting directly to the head-of-state. Such agencies exist already in many states. The personnel of the agency could include representatives of government, press, trade unions, scientific and technical societies, national academies of science and other organizations, as well as specialists and technicians.

In a paper incorporated as an appendix in this source*, a detailed proposal for a chemical control system (CCS) is made. The CCS is envisaged as a national control organ which would:

> ...monitor all economic and industrial activities connected with dual purpose agents and with essential ingredients required in the production of single purpose agents...To accomplish this task, the industrial enterprises which produce, transport or use controlled materials are required to maintain internal records and prepare periodic reports of all relevant activities. To ensure the accuracy of these industrial level reports, a number of checks and balances have been incorporated into the system, such as registration of all industrial establishments, authorization of production and use quantities, reports from two or more independent sources on all material movement, and independent audits of the records and material control procedures at production plants. The reports submitted by an individual plant are subject to verification against reports from customers, suppliers and transportation companies with which it does business.

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* Pittaway, A.R., et al. "Paper prepared for discussion of the working group meeting on 16-18 December 1972". In Ibid., pp. 51-130.

E4(A73)

The administration and operation of the CCS is divided between two organizational levels - National Control Agencies and industry. The National Control Agency is responsible for the operation and control of the system within its country's borders and must provide verification to other National Agencies that industrial establishments have complied with all provisions of the CCS. The industrial level is required to follow authorized material handling procedures, maintain minimum accounting records, and report to the National Control Agency. (pp. 61-62)

A general list of functions performed by each level is shown in the table below*.

Detailed descriptions of the individual components of this system are provided in the source.

FUNCTIONS OF THE TWO ORGANIZATIONAL LEVELS WITHIN THE CCS

LEVELS	Functions
National Control Agency	1. Exercise primary legal, administrative and technical controls
	2. License all production, use and transportation of controlled materials
	3. License, control and inspect international trade in controlled materials
	4. Establish national records for each controlled material and plant
	5. Verify accuracy of industrial level reports
	6. Audit/inspect industrial records and operations
	7. Report activity in controlled materials, nationally and internationally
Industry	1. Furnish data to National Control Agency pertinent to controlled material
	2. Follow material control procedures as directed by national government
	3. Maintain records as directed by national government
	4. Respond to challenge audit/inspections by National Control Agency

* Ibid., Table 1, p. 62.

PROPOSAL ABSTRACT E5(G74)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) Records monitoring - economic
      - plant
   b) On-site inspection - selective
      - obligatory
   c) Short-range sensors - sampling
      - monitoring devices
   d) National self-supervision
   e) International control organization

3. Source:
   United States. "Working paper on diversion of commercial chemicals to weapons", CCD/437, 16 July 1974.
   See also: CCD/311, 25 August 1970 (Abstract E2(G70)).

4. Summary:

This paper is concerned with the establishment of a control system to monitor the production, transportation and use of all phosphorus compounds which can be used in the production of a nerve gas. It is a follow-on paper to CCD/311. The objective of such a system would be to ensure that all consumption of divertible phosphorus compounds could be traced to legitimate activities. To accomplish this task, the industrial enterprises which handle these materials would be required to maintain detailed internal records and to prepare periodic reports on all relevant activities. In addition, all transfers between plants would have to be documented. Checks would be incorporated into the system to ensure accuracy of these industrial level reports.

The administration and operation of the control system could be divided among several levels. First, industrial enterprises would be required to follow authorized material handling procedures, maintain adequate records and report to the national control agency. Second, a national body would have primary responsibility for applying controls to enterprises within its jurisdiction. It would report to the international control agency. Third, an international agency would oversee the entire system, analyze and audit reports from each national agency and monitor international trade in controlled materials.

There are three basic verification techniques which can be used by the control agencies to determine the accuracy of the reports:

E5(G74)

1) analysis of statistical information in the reports,
2) examination and analysis of records, and
3) "technical inspection".

The international body, in order to verify the system's reporting accuracy, would regularly analyze reports of national control agencies and perhaps those of certain enterprises. Periodically, the international agency would audit relevant records of the national agency and in addition would have authority to audit either the national agency's or any enterprise's records if there was a discrepancy.

It would also be necessary to develop a reliable system based on technical inspection to detect false records. Technical inspection includes:

1) visits to certain chemical plants,
2) technical analysis of plant operating data,
3) analysis of samples of phosphorus-containing chemicals which are in interplant transit, and
4) monitoring of recording devices to provide independent information on plant production rates.

The paper continues by describing two evasion methods. First, phosphorus material could be diverted from within the system or, second, it could be obtained from sources outside the system's control. The paper mentions nine possible ways in which the former type of evasion could be accomplished, three of which are possible in the American phosphorus industry. Six ways of evading from outside the system are listed.

This control system differs from that described in CCD/311 primarily by the inclusion of technical inspection. Here, statistical data provide the background for combined use of audit and technical inspection procedures which increases the utility of the statistical data. "Conventional" on-site inspection is not highly effective in this field. Technical inspection combining analysis of plant operating records with conventional records auditing procedures would not require actual presence on-site but would require access to all plant records. Technical inspection methods 3 and 4 above would reveal evasions undetectable by other means, (see the working paper for examples).

For the control system to be an effective deterrent to violations:

1) the international control agency must have access to individual plant records;
2) the international agency should be allowed to conduct independent investigations of a plant's records; and
3) technical inspection should be an integral part of the data validation procedure since a standard records audit is insufficient.

In conclusion the paper claims that the procedures described are not sufficient in themselves to provide adequate assurance of compliance but could play a useful role in conjunction with other verification methods.

PROPOSAL ABSTRACT E6(A75)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - stockpiles

2. Verification Type:
   a) Records monitoring - economic
   - plant
   - sampling
   b) On-site inspection - selective

3. Source:
   Roberts, R.E. and C.A. Romine. "The Use of Records in the Verification of CW Stockpile Destruction". In Stockholm International Peace Research Institute, Chemical Disarmament: New Weapons for Old, pp. 114-124. New York: Humanities Press, 1975.

4. Summary:
   In order to ascertain whether all of a country's stockpile of CWs had been destroyed pursuant to a CW Treaty the authors suggest that records on all CW agents and munitions produced during the last 35 years be provided for verification purposes. Analysis of these records would permit the derivation of reasonably accurate estimates of past production which could be compared with the quantities destroyed.
   If complete access to records about stockpiles were provided to inspectors they could derive as complete an estimate of the stockpile as the inspected nation. But it is unlikely that such full access will be provided.
   To determine what and how much of each CW is in the stockpile

requires:

1) determination of what is in the stockpile when the agents are destroyed which requires information reflecting all past entries and exits from the stockpile,
2) a continuing monitoring of entries and exits during the destruction phase,
3) a ban or controls on new production or imports of CWs during the destruction phase, and
4) some means of dealing with the special problems posed by dual-purpose and binary agents.

Ensuring that what is actually destroyed is the CW claimed can only be done by physical access at the destruction site. Samples of the agent must be taken and the total quantity being destroyed must be measured. This can be accomplished by the use of inspectors at the destruction site or by shipping the agents to an international destruction site. While provision of records will not serve to ensure that the specific agent claimed is actually being destroyed, some information given at this stage will reduce the intrusiveness needed to verify that the whole stockpile has been destroyed (see below).

Historical records involve some problems from the verification point of view:

1) Were the records accurate when made? Record accuracy can suffer during the start-up phase and during crises. There is also the practice of some plant managers adjusting statistics to conform with imposed quotas.
2) Were all aspects of the acquisition and consumption of the stockpile covered in the original records system?
3) Have all records been retained?

Evasion possibilities in regard to historical records are limited. Counterfeiting original records, because of the interlocking nature of record systems, would require an extensive effort. If original documents are provided, tests of the paper's age could be useful. Withholding certain historical records would also be difficult because of the interlocking aspect. In contrast to historical records, falsifying current records would be much easier.

Establishing the magnitude of the stockpile would require records which were mutually supporting and interlocked on the following activities:

1) production,
2) importation,
3) transportation,
4) stockpiling,
5) exportation,
6) consumption, and
7) destruction.

There is a vast number of records which can be drawn on to provide this information some of which the paper lists. The intrusiveness of the verification system could be reduced by judiciously selecting the set of records to be examined.

The interlocking of the record system is a key feature of the verification system proposed. Records interlock in at least five dimensions:

1) Summarization. This involves source documents which are summarized in journal or ledger entries.
2) Inter-enterprise. These are generated when a commodity moves from one site to another.
3) Supporting. These arise when two different types of documents are generated by the same event.
4) Hierarchical. These link different levels in the organization's chain of command.
5) Chronological. These link one time period with another.

The paper proposes two verification strategies. The first is based upon a determination of stockpile composition and magnitude prior to actual destruction of the CWs. Five levels of intrusiveness are postulated and summarized in a figure presented in the paper. For three of these levels intrusiveness and costs of the verification system would be great.

The alternative approach favoured by the authors is to rely on information supplied during the destruction phase to reduce the needs for other information. If data on the nature of the agent, the quantity in the lot, where it was produced, where it was stockpiled and when it was produced was obtained during destruction and validated as far as possible by inspectors, it would permit the creation of a validated data base containing most of the elements of information describing a national stockpile without any penetration of the national records. After destruction was completed the verification team could request limited access to selected parts of the national records to verify the accumulated data. Sample validation of this data base capitalizing on several forms of interlocking might suffice.

E7(A63)

PROPOSAL ABSTRACT E7(A63)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) Records monitoring - economic
      - plant
      - sampling
   b) Literature survey - budgetary analysis
   c) On-site inspection - selective
      - sampling

3. Source:
   Barnstein, Morris. "Inspection of Economic Records as an Arms Control Technique". Journal of Conflict Resolution 7 (1963): 404-412.

4. Summary:

The paper examines the nature, utility and limitations of inspection of economic records as a verification technique. The term "economic records" as used here is broad and includes records:

1) relating to all sectors of economic activity,
2) expressed in physical or monetary terms,
3) pertaining to various levels of economic organization,
4) available at centralized records centers or at individual records keeping units, and
5) published and non-published.

Essentially records monitoring consists of locating pertinent records and verifying their authenticity. Consistency checks by highly qualified experts are the heart of the method. These involve checking the accuracy of reported information against appropriate related data to determine consistency. The reliability of such consistency tests depends upon the access of inspectors (measured in quantity, variety and degree of detail of records) and the qualifications of the inspectors. It is important to emphasize the need to examine past records in these consistency tests. This enables the inspectors to gain the necessary perspective for assessing current records and it increases the difficulties of falsifying records.

Records monitoring could be useful for discovering clandestine production in undeclared facilities as well as declared ones. It is clear, however, that the technique alone is insufficient. To conduct valid consistency tests it would be necessary to employ physical on-site inspections on a random basis to ensure the authenticity of selected records. On-site inspection and other verification techniques would also be used to follow-up any evidence of a violation revealed by records monitoring. There is a similarity between records monitoring and other verification techniques. While records monitoring can not completely

substitute for other methods, it can, for example, reduce the amount of on-site inspection which otherwise would be necessary.

Three problems with records monitoring are identified. First, there may be problems in the availability of records, such as whether they are kept at all, where they are located and what form they take. A preliminary examination of records-keeping practices in the USSR and the USA leads the author to believe that it would not be technically difficult to design a records monitoring program for both. He discusses several similarities and several differences in the practices of the two countries which would affect records monitoring. It would be essential however, that, in addition to existing records in both countries, some special records would have to be maintained for the purpose of verification. It might also be desirable to standardize records-keeping procedures between countries.

To avoid being overwhelmed by detail the records inspectorate would have to focus on selected records. To this end, it is essential to identify critical items in the production of various weapons, upon which the inspectorate could concentrate its records monitoring activities. Another reason for limiting the extent of records monitoring activities is that it would reduce the amount of access required by the inspectorate and thereby perhaps increase the method's political acceptability.

The author suggests the following records monitoring program:

1) regular and detailed monitoring of selected key records,
2) random sample monitoring of selected other records,
3) random sample on-site inspection to confirm the accuracy of records, and
4) follow-up on-site inspections to investigate any suspected violations revealed by records monitoring.

The author points out the lack of satisfactory estimates concerning the reliability of the method and its cost. He recommends further research along five lines to provide this information.

AD-A124 775 COMPENDIUM OF ARMS CONTROL VERIFICATION PROPOSALS(U) 3/6
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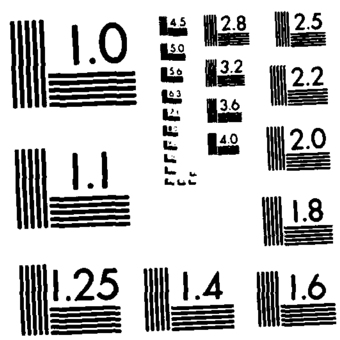

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PROPOSAL ABSTRACT E8(A63)

1. Arms Control Problem:
   Any arms control problem

2. Verification Type:
   a) Records monitoring - personnel
   b) Literature survey
   c) On-site inspection - general
                         - sampling
   d) Remote sensors

3. Source:
   Bowen, Russel J. "Soviet Research and Development: Some Implications for Arms Control Inspection". Journal of Conflict Resolution 7 (1963): 426-448.

4. Summary:
Regarding on-site inspection as an approach to verifying restrictions on military research and development, the author points out the large effort that would be needed to implement a general on-site inspection system even one based on random sampling. Physical inspection of all possible R and D facilities should therefore not be relied upon. More useful would be keeping track of Soviet scientists and technicians. Several foci in the Soviet R & D community for such monitoring of personnel are suggested. Checking the use of Soviet information centres might perhaps be of some use also, as might media analysis. Finally, the author suggests remote sensing of test areas.

PROPOSAL ABSTRACT E9(A65)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Records monitoring-plant

3. Source:
   Unclassified Summary: Validation of Records of Production: Final Report. Report to United States Arms Control and Disarmament Agency. Fullerton California: Hughes Aircraft Company, December 1965.

4. Summary:

Given the possibility that the Soviet Union might find an exchange of production records more acceptable than other verification methods, together with the possibility that production records could provide an adequate means for verifying existing stockpiles of armaments, this report summarizes research into the feasibility of falsifying records of production and the feasibility of discovering such falsifications. Examination of actual production records of several processes at the manufacturing enterprise level was undertaken as part of this study. It was assumed that the records would be inspected by adversary personnel, not international agency staff, and that there were no limitations on access to production records.

It is essential that original records, not copies, be made available in the form in which they have been stored. The method of detecting falsification of production records which was developed consists of four kinds of checks:

1. Checks having reference to the administrative context of the plant,
2. Checks of the over-all activity of the enterprise,
3. Checks of the fundamental relation between input and output, and
4. Checks on the continuity of the enterprise.

The report also catalogues hiding techniques and the efficacy of the above method in detecting falsification. It concludes that a method of detecting falsification of production records merits serious attention as a technically promising inspection technique that could make significant contributions to verifying existing armaments stockpiles.

CHAPTER F

NON-PHYSICAL/PSYCHOLOGICAL INSPECTION

Non-physical/psychological inspection is founded on the idea that it is people who violate arms control agreements, not things. As such it constitutes a novel departure from physical inspection which seeks to directly monitor the objects of agreements, be they missiles, nuclear materials or conventional forces. Non-physical/psychological inspection concentrates on people's knowledge of violations and attempts to devise plans for extracting this knowledge. The approach assumes that a government whose citizens were prepared and able to report their knowledge of violations would be hard pressed to secretly circumvent agreements or otherwise conceal violations.

Such systems differ in terms of the methods they employ and the degree of contact they seek to establish in order to extract information. The lengths to which they go vary anywhere from monitoring news releases and other open literature to proposing the implantation of devices in the brains of certain individuals to ensure their cooperation. Most systems, in fact, combine a number of methods in the hope of covering as great a portion of the population as possible. Since certain people are more likely to have knowledge of violations than others, the techniques employed must be designed to take this into account. Very general and loose methods may be appropriate for the general public, while more intense (and generally more intrusive) methods may be desired for those most likely to have knowledge of violations, such as military scientists and politicians.

Another source of variation within this category of verification concerns the nature of the party responsible for implementing the monitoring system. While most often an international inspectorate is envisaged, in which inspectors would seek individuals with knowledge of violations, some proposals suggest national systems which would utilize a national sense of honour to motivate voluntary reports. While national systems avoid the problem of international intrusion, they are not amenable to establishing confidence on the part of other parties to a treaty. In short, national systems lack high credibility. However, some aspects of national systems, for example, announcements by high officials asking for public support for arms control agreements, can be monitored by non-intrusive means.

Both active and passive systems have been proposed. Under the active mode, inspectors would conduct interrogations and interviews. The passive mode, on the other hand, would work within the framework of a system specially tailored to encourage voluntary disclosures of information. Passive systems often provide for rewards and penalties, and seek to establish channels of communication to ensure safety for informants. As mentioned earlier, most systems envisage a combination of these two approaches.

Contents of Chapter F:

Arms Control Objective	Number of Proposal Abstracts
Nuclear weapons	1
General and complete disarmament	1
Any arms control agreement	6
	8

F1(A63)

PROPOSAL ABSTRACT F1(A63)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Non-physical/psychological inspection
   b) International control organization

3. Source:
   Bohn, L.C. "Whose Nuclear Test: Nonphysical Inspection and the Nuclear Test Ban". In Weapons Management in World Politics: Proceedings of the International Arms Control Symposium, December 17-20, 1962, pp. 474-487. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:

This proposal attempts to deal with the problem of uncovering the source of tests made illegal by a comprehensive nuclear test ban. The author notes that while seismic and radiation detection techniques can generally determine that a nuclear explosion has occurred, these systems are not always able to locate the event. A non-physical inspection approach is offered as a supplement to physical inspection.

Five basic subsystems are suggested in this proposal:

1) A limited public reporting system would encourage citizens to report evidence of nuclear tests or related activities to an international control agency. Incentives, as well as guarantees of safety, would be offered to informants.
2) Periodic questioning of selected individuals before an international committee would be undertaken. This might be limited to perhaps 100 top officials and scientists in countries with a known or potential nuclear capability. The aim would be to discover participation in or knowledge of illegal activities connected with nuclear tests. Legitimate matters of national security would be safeguarded.
3) Cooperative nuclear research by scientists from around the world would encourage close personal relationships between leading nuclear scientists so that a violation of an agreement would be less likely to remain the secret of one or two. The chances of a fundamental nuclear breakthough by

only one nation would be minimized as well. Asylum could be provided for a scientist wishing to report violations.

4) Exchanges of scientific personnel between potential "enemy" nations would offer benefits similar to item 3 above.
5) If and only if it could be developed as a reliable technique, polygraph questioning of selected individuals might be used to assure the truthfulness of indivduals under questioning. A limited number of people would be required to undergo such tests.

PROPOSAL ABSTRACT F2(A62)

1. Arms Control Problem:
   a) General and complete disarmament
   b) Regional arms control - Europe

2. Verification Type:
   a) Non-physical/psychological inspection
   b) International control organization

3. Source:
   Melman, Seymour. "Inspection by the People". In Preventing World War III: Some Proposals, pp. 40-51. Edited by Qunicy Wright, William M. Evan and Morton Deutsch. New York: Simon and Schuster, 1962.

4. Summary:

Inspection by the people involves an effort to organize the population of the inspected country into a random, far-flung network of people who would report to an international disarmament organization any evidence of evasion activity. Any major evasion effort would require the collaboration of thousands and the substantial backing by the surrounding population as well as an important segment of the government.

The principle legal requirement of this method is that each country require in its code of law that every citizen report to the IDO any evidence of evasion. Failure to do so would be punishable. Included in the disarmament agreement would be provisions for the right of the IDO to address itself to the population of a country including the right to minimal use of the press, radio, TV and face-to-face communication. Leaders of each country would also be required to participate in the IDO's public statements to the population.

F2(A62)
F3(A61)

The disarmament agreement would also include means for the population to reach the inspectorate. Test mail could be used to ensure that the postal service provided an access route. By granting diplomatic immunity to IDO personnel, any person reporting an evasion could be assured that if he wanted protection of the IDO even to the extent of being moved abroad he could have it. The IDO might also be connected with information centers and technical libraries to which the population would have free access. Rewards for reporting evasions and guarantees of protection would be used.

PROPOSAL ABSTRACT F3(A61)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) Non-physical/psychological inspection
   b) International control organization

3. Source:
   Bohn, L.C. "Non-Physical Inspection Techniques". In *Arms Control, Disarmament and National Security*, pp. 347-364. Edited by D.G. Brennan. New York: Braziller, 1961.
   See also: "Non-physical techniques of disarmament inspection". In *Preventing World War III: Some Proposals*, pp. 20-39. Edited by Quincy Wright, William M. Evan, and Morton Deutsch. New York: Simon and Schuster, 1962.

4. Summary:

This proposal departs from the physical inspection approach in which there is a focus on violations themselves as physical phenomena and concentrates instead on knowledge concerning violations. Methods are envisaged that would motivate individuals who learn of violations to bring their knowledge to the attention of an International Control Organization. Such individuals might include guards, scientists, clerks, accountants, explorers, aviators, police, technicians, and perhaps highly placed politicians. Knowledge detection could be approached in both voluntary and involuntary ways.

Voluntary reports might be encouraged in several ways including official government support for the arms control agreement and for public assistance in monitoring compliance. There might be a requirement that governments actively promote popular participation in the verification process. Legal penalties for withholding information, as well as rewards for reporting could be instituted. Safe channels for communicating reports would be required, free of national government interference or intimidation. The whole system could be tested if the international control organization periodically introduced "dummy" violations, to see if they were reported.

There is an obvious assumption here that the most likely violations of arms control agreements would require the participation of relatively large numbers of people. In order to counter the argument that a small group might be able to violate an agreement without being detected, it is further proposed that each party to the agreement should draw up a list of perhaps one thousand individuals who would be candidates for closer inspection. Closer inspection would involve the use of sensing devices that measure the psychological reactions of an individual as he is questioned about his participation in, or knowledge of a violation of an arms control agreement. "Lie detectors" are an example of such devices.

In the article included in Preventing World War III, Bohn lists some of the critical questions which must be researched and answered before the utility of the non-physical inspection approach can be determined.

PROPOSAL ABSTRACT F4(A61)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) Non-physical/psychological inspection
   b) International control organization

3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In Arms Control: Issues for the Public, pp. 123-126. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

4. Summary:
   This proposal seeks to verify an arms control agreement by utilizing the knowledge regarding violations possessed by specific groups of individuals or by the population as a whole. The following methods are suggested:
   1) The treaty could give the international inspectorate the right to ask any citizen questions concerning possible treaty violations. If desired, heads of state could be excluded without much loss of effectiveness.
   2) The treaty could legally require all citizens (except possibly heads of state) to answer all relevant questions when interviewed by the inspectorate. It could provide for punishment of citizens who refuse to answer relevant questions or who are found guilty of lying to the international inspectorate.
   3) Substantial rewards (e.g. $100,000 or more non-taxable) could be provided for citizens who report verifiable violations to the inspectorate.
   4) Assuming a reliable lie detector could be developed, the treaty could give the inspectorate the right to use such an instrument in their interviews.
   5) The treaty could make it the duty of each citizen with knowledge of any treaty violations to report it to the international inspectorate. Failure to report could be made punishable.
   6) The treaty could guarantee to a person reporting a violation that he and his family could obtain sanctuary abroad whenever they so desire.
   7) There could be an agreement that the leaders of both sides must give such provisions their enthusiastic support on a regular basis through the mass media.

PROPOSAL ABSTRACT F5(A62)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Non-physical/psychological inspection

3. Source:
   Gerard, R.W. "Truth Detection". In Preventing World War III: Some Proposals, pp. 52-61. Edited by Quincy Wright. New York: Simon and Schuster, 1962.

4. Summary:
   The author proposes that key official spokeman of countries be subjected to "truth detection" procedures administered by personnel from an adversary state or the UN. Such procedures could be applied during both private negotiations and public addresses.
   "Truth detection", as understood by the author would include use of polygraphs, measurement of respiration, heart rate, skin resistence etc., to detect truth or falsehoods under questioning. Presumably "... with growing conviction that false statements would be caught up, spokesmen would tell the truth publicly and their hearers would come to have some trust in the truth of these statements".

PROPOSAL ABSTRACT F6(A63)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Non-physical/psychological inspection

3. Source:
   Deutsch, K.W. "The Commitment of National Legitimacy Symbols as a Verification Technique". In Weapons Management in World Politics: Proceedings of the International Arms Control Symposium, December 17-20, 1962, pp. 454-463. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:
   This proposal is based on the concept of "national legitimacy symbols". The author holds that in every state: "legitimacy...represents the assurance of continued systems integration and thus is a vital systems requirement,

the 'legitimacy system' of any state or society forms one of its most vital - and potentially vulnerable institutions". (p. 456)

The system proposed here and based on this idea of legitimacy is essentially a knowledge detection system. A substantial part of the population would be encouraged to alter their value system such that they would reject any **obligation** to keep any secret related to national evasion of an arms limitation agreement and would refuse to give even passive support to the concealment of any evasion. The author cites figures indicating that experience in World War II supports confidence in the capacity of populations to cooperate with security inspectors. As well, "public opinion surveys showed that already in the 1950's in a number of Western countries including the United States, between 50 and 80 percent of the respondents expressed their readiness in the event of an arms control agreement to reveal 'national' secrets of arms control evasion to foreign inspectors entitled to the information". (p. 460-61) These examples indicate that the development of this attitude would not be too difficult.

Essentially, the author believes that by the pledging of national legitimacy symbols - perhaps the word "honour" could be substituted here - the process described above would be initiated. The countries involved would commit their highest organs of authority, on the most solemn national occasions of each year, to address direct and varied messages to all the citizens, particularly to scientists, officials, and members of the armed forces, reminding them of their national and personal obligation to comply faithfully with the arms limitations and to report on adherence to the provisions of the agreement. The messages would remind the public in each country of their obligations to uphold and defend these agreements, not only for the sake of their national honour and their continued ability to trust their own governments and one another, but also for the sake of their own survival, and that of their families, communities and nation. Such addresses could be made for instance, on July 4, New Years Day and on May 30 (Memorial Day) in the United States, and on May 1, November 7 and the New Years Day in the Soviet Union. This process should be incorporated into domestic law by all parties. Presidents, congresses and parliaments could participate in developing this commitment of legitimacy symbols. The mass media and youth clubs could also participate; in fact, all manner of organizations should be encouraged to take part. The author contends that with such broad participation, secret violations of arms control agreements would be nearly impossible.

PROPOSAL ABSTRACT F7(A63)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Non-physical/psychological inspection

3. Source:
   McNeil, E.B. "Psychological Inspection". In *Weapons Management in World Politics: Proceedings of the International Arms Control Symposium, December 17-20, 1962*, pp. 124-136. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:

Like other proposals for psychological verification systems, this one is based on the idea that "things" do not violate agreements; people do. The author maintains that several attitudes can be detected by psychological inspection:

1) proneness to violate,
2) intent to violate,
3) guilty knowledge of past violations,
4) violations not covered by the agreement, and
5) isolated violations not inspectable by physical means.

The proposal discusses several of the techniques potentially applicable to a psychological verification system including:

1) intelligence,
2) questionnaires,
3) interviews and interrogations,
4) objective tests,
5) projective tests,
6) lie-detection,
7) hypnosis,
8) analysis of variations in the nervous system and body chemistry,
9) psychotomimetic drugs (LSD_{25}, etc),
10) truth serums,
11) mood transforming drugs,
12) sensory deprivation,
13) brainwashing and isolation from a frame of reference, and
14) electrode implantation

Admitting that several of these techniques may be excessively intrusive, the author suggests a practical minimum of psychological inspection whereby inspectors would be trained to develop their observation skills much as are clinical psychologists. This would help them to detect suspicious activities and attitudes without excessive intrusion.

F8(A63)

PROPOSAL ABSTRACT F8(A63)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) Non-physical/psychological inspection
   b) Literature survey

3. Source:
   O'Sullivan, T.C. "Social Inspection". In Weapons Management in World Politics: Proceedings of the International Arms Control Symposium, December 17-20, 1962. Edited by J.D. Singer. Ann Arbor, Michigan: 1963.

4. Summary:
   The system proposed here, "social inspection", concentrates on examining the society in which the violation occurs. Information concerning a violation "would be gathered through tapping memories of people, observing their behaviour, analysing organized behaviour, etc". (p. 466)
   The author suggests four forms of social inspection, varying primarily in the degree of contact:
   1) The most intimate forms are pyschological and physiological examination. They might be performed on a small body of the national decision-making elite, members of which would be aware of any cheating.
   2) The next level involves less intensive personal contact with, and observation of, a broader but still select group who might have participated in any violations or who might be aware of them through professional or personal contacts.
   3) The third level involves observation of organized activities, that is, analysis of social patterns, group behaviour, etc.
   4) Finally, the least intimate form of social inspection involves media analysis, detailed analysis of newspapers and professional journals, public pronouncements, etc.

   While recognizing that the techniques needed to apply this system are not sufficiently developed to permit its rapid implementation, the author believes this to be a matter of time and effort.
   Both an active and passive mode is envisaged for this system. The active mode has been described above. The

passive mode would consist of a system of communication between the general public and the disarmament verification organization which would encourage and facilitate the transfer of knowledge regarding violations of arms control agreements. An efficient, confidential mode of knowledge transfer, perhaps could, perhaps, be encouraged by reward and penalties.

CHAPTER 6

SHORT-RANGE SENSORS

The discussion in this chapter focusses on relatively short-range sensing devices. Because of the limited range of these devices their use usually implies some form of physical entry into the territory of the party being monitored either to install and maintain the sensor or because the technique is intended for use by personnel as part of a system of on-site inspection.

A. Inspection Equipment

Two types of close range sensors will be discussed in this chapter. The first category includes devices and techniques which are intended to be carried or employed by on-site inspectors in the course of their duties. These might include devices like portable chemical agent alarms or Geiger counters. Portable laboratories for testing samples as well as the techniques which could be used in these laboratories can also be placed into this category.

The use of such equipment may well be described as intrusive in the sense that it could provide an opportunity for collecting military or proprietory information outside the area permitted by the arms control agreement. Thus the agreement may well have to specify the inspection equipment which can be used.

B. Automatic Sensors

The second cateogry of short-range sensors discussed in this chapter includes devices implanted relatively near the object to be monitored and left unattended. These sensors would be periodically visited by inspectors to collect recorded data or monitored from a distance by the verification body. An example of such devices are special seals which might be used to ensure that valves, doors and other equipment in a production plant are kept closed. So-called "black boxes" are treated here as a form of this type of sensor. The term "black box" is intentionally ill-defined, perhaps so those being monitored will not know exactly what is being recorded. It has sometimes been proposed that the country being monitored should be provided with a duplicate "black box" so that it can check that its mechanism will collect only information authorized by the arms control agreement.

Many sensors developed originally for use in combat situations to monitor enemy troop and vehicular movements have utility for verification of arms control agreements. They might be applied directly with little modification, as in monitoring a demilitarized zone, or they might serve as a basis for further research to design a more appropriate verification device. A number of categories of such devices are listed below in order to give a general appreciation of the state of technology in this area.

1) Chemical sensors include a portable alarm system for detecting nerve gas agents below lethal concentrations, capable of being transported by an inspector and possibly for modification as an automatic sensing device. It might also be adaptable for the detection of other chemical agents. Other sensors include one for detecting chemical emanations from the human body.
2) Acoustic sensors which detect sounds in the immediate vicinity and transmit a signal to a remote controller for

evaluation.

3) Seismic sensors which detect movements of traffic or even of personnel within a range of a few metres.
4) Radio frequency detectors used to detect the presence of radio frequency emissions from equipment, e.g. from spark plugs in the immediate vicinity.
5) Pressure sensitive sensors which transmit a signal when touched.
6) Magnetic sensors used for detecting metallic objects such as vehicles or rifles.
7) Visual surveillance devices include a wide variety of photographic equipment, television, low light television and infrared sensors.

Although the implantation of unattended sensing devices on the territory of a state can be done clandestinely in a state of war it must be done openly when done for the purpose of monitoring an arms control agreement, with the concurrence of the state being monitored. The limitations of specific sensors compared with the general observational powers of a human inspector may make them more acceptable than inspection teams. Their use may also reduce the manpower costs of the verification system.

Contents of Chapter G:

Arms Control Objective	Number of Proposal Abstracts
Nuclear weapons	4
Chemical and biological weapons	6
Any arms control agreement	1
	11

Note:

Three documents were received too late to be included in the Compendium. They all involve short-range sensors and all are highly relevant. Particularly noteworthy is the second.

1. Lang, Owen B. and Kenneth W. Yee. Tamper-Resistant Television Surveillance System. Washington, D.C.: National Bureau of Standards, May 1975. NBSIR 75-707.

2. Leutters, Frederick O. Containment and Surveillance Equipment Compendium. Albuquerque, New Mexico: Sandia National Laboratories, February, 1980. SAND-80-0002.

3. Myre, W.C. and M.J. Eaton. A Systems Approach to Tamper Protection. Albuquerque, New Mexico: Sandia National Laboratories, 1980. SAND-80-0-0721C.

PROPOSAL ABSTRACT G1(G66)

1. Arms Control Problem:
   Nuclear weapons - fissionable materials "cutoff"

2. Verification Type:
   a) Short-range sensors - monitoring devices
   b) On-site inspection - selective

3. Source:
   United States. "Working paper on an inspection method for verifying the status of shutdown plutonium production reactors". ENDC/174, 14 April 1966.
   For more detail see: "Description of a monitoring system for shutdown nuclear reactors". ENDC/176 and Corr. 1, 11 August 1966.

4. Summary:

The paper describes a method of ensuring continued shutdown of plutonium producing reactors during periods between inspections. The method involves four concepts:

1) Use of a "target material" placed in a reactor case, which is of such a nature that it will become radioactive in the event of reactor operation;
2) Use of wire or tape to fix this target material in position;
3) The tape is of such a nature that it is unique and hence any substitution of the equipment would be detected; and
4) Use of an exterior seal at each end of the channel in which the target material is inserted, to assure the inspection team that the wire or tape will have remained in position between inspections.

An international inspection team of two professional-level and two technician-level specialists can install the system without damaging the reactor, in about one week. Return inspections which would be spaced several months apart and involve checking seals and replacing tapes, would only take one or two days each.

G2(G62)

PROPOSAL ABSTRACT G2(G62)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Short-range sensors - monitoring devices
   b) Seismic sensors
   c) International control organization

3. Source:
   United Kingdom. "A Document prepared by 3 United States and 3 Soviet scientists attending the Xth Conference on Science and World Affairs, Cambridge 1962". ENDC/66, 4 December 1962.

4. Summary:

   The six scientists suggest the use of Automatic Recording Stations which would be sealed and tamper-proof as well as self-contained. They would be installed by the host government and periodically returned to the International Control Commission for inspection, replacement and repair. A standard explosive blast would be used for calibration purposes. The number of stations would be large enough to provide a good check of the seismic data supplied by a world-wide network of seismic stations. Such an arrangement would reduce the possibility of unidentified events and increase location precision. It would also mean the Commission will need fewer on-site inspections of suspicious events.

   The Commission would be able to request immediate return of the sealed instruments. Seismic data would be collected periodically by the Commission. The stations located in the USSR could be manufactured in the US and vice-versa.

5. Selected Comments of States:

   In an Izvestiya article reproduced as a Soviet working paper ENDC/67 (7 December 1962) several Soviet scientists support the proposal for automatic seismic stations. They suggest servicing of the stations be carried out by periodically changing standard sets of cassettes sealed by an international authority and loaded with films and power supply units.

PROPOSAL ABSTRACT G3(A69)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles

2. Verification Type:
   Short-range sensors - monitoring devices

3. Source:
   Persley, Merle J., James W. Kauffman, and James P. Moran. Further Investigation of Rocket Launch-Phase Inspection Techniques: Summary. Cambridge, Mass.: Block Engineering Inc., 1969. ST-132/R-36. NTIS AD 701 255.

4. Summary:

The aim of the study reported here was to develop techniques for the arms control monitoring of missile and space vehicle launches. The report evaluates the results of actual trials at a missile test range of a comprehensive, mobile, passive, optical instrumentation system composed of cameras, spectrometers and ancillary equipment.

The study concluded that remote optical sensing techniques can provide meaningful information for arms control missile inspection purposes. Missile characteristics which can be determined by such methods include: thrust, specific impulse, propellant type, construction details, launch weight and event times. Several improvements to the instrumentation are recommended for further study. Study of the capabilities of airborne and satellite-borne platforms for inspection purposes is also recommended. A separate volume of the report describes in detail the instrumentation used.

PROPOSAL ABSTRACT G4(A71)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - anti-ballistic missile system.

2. Verification Type:
   Short-range sensors - monitoring devices

3. Source:
   Fubini, E. "Reconnaissance and Surveillance as Essential Elements of Peace", and summary of discussion. In Impact of New Technologies on The Arms Race, pp. 152-160. Edited by B.T. Feld, et al. Cambridge, Mass.: MIT Press, 1971.

4. Summary:

The author contends that to verify a SALT agreement adequately, satellite reconnaissance is not sufficient. Satellites suffer from a number of weakness including:

1) limitations imposed by the weather and nightfall,
2) limitations imposed by size and cost factors, and
3) limitations resulting from the opacity of many objects.

In order to supplement verification by satellite, the author suggests:

The great usefulness of "transparent black boxes" which could be located anywhere in the US or Soviet territory and equipped with a sensor of some kind. The location could easily be checked, the size would be small, the sensors would limit strictly the scope of the information, with both parties fully knowledgeable of the details of the box. A typical transparent box would consist of a camera capable of taking consecutive pictures (say every 30 seconds) of a missile silo to prove that new missiles are not being substituted for old ones (p. 154).*

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* The use of the term "black box" in this context may have some unfortunate connotations and may be somewhat of a misnomer. In behaviourist theory, the term "black box" is used to refer to an element of a system, the internal workings of which can not be directly observed. Only indirect measurements of how the "black box" behaves can give insight into its internal mechanisms. In this proposal the "black box" is not "black" at all but "transparent".

The major advantage of such a system is that it is limited as to the scope of the information it is capable of providing. In a situation of partial trust, this "limitedness" could help reduce tensions because the party being monitored knows what he is facing.

The objection that the "black box" cannot provide 100% assurance is not valid, according to Fubini. No system of verification can do this.

A number of interesting points emerged in the subsequent discussion of Fubini's presentation. It was pointed out that there had been extensive consideration given to the idea of "black boxes" during the test ban negotiations of the early sixties. The main stumbling block was the demand for absolute assurance of compliance which resulted in the small monitoring boxes growing into "unwieldy monstrosities". This unfortunate experience may have blinded governments to the possible utility of "black boxes" as a means of verification.

> If the black box were recognized from the beginning to have only a limited function, then it need not grow into a monstrosity. An example of such a limited use for a black box would be the monitoring of a large, sophisticated commercial air-traffic control radar in order to guarantee that it does not have an ABM capability. The properties of limitedness and pre-determination which are built into a black box are not possible with air or satellite surveillance; and especially not with human reconnaissance...It is true that one side could jam such a device and that no-one could prevent this, but the box could be so constructed that the other side would know that the box was being jammed (p. 159).

G5(G71)

PROPOSAL ABSTRACT G5(G71)

1. Arms Control Problem:
   Chemical weapons - production
   - research and development
   - stockpiling

2. Verification Type:
   a) Short-range sensors - sampling
   b) International exchange of information
   c) National self-supervision

3. Source:
   Canada. "Working paper on atmospheric sensing and verification of a ban on development, production and stockpiling of chemical weapons". CCD/334, 8 July 1971.

4. Summary:

Because of technical and physical limitations, remote air sampling is not feasible as a verification method save perhaps in the case of monitoring small countries and even then only for certain agents.

It might, however, be possible to create a national network of monitoring stations which would gather data on the presence of organophosphorus compounds in the atmosphere of a state. Such stations would be analogous to existing North American stations which measure the concentration of air pollutants over cities. The nerve agents have their own distinct chemical signatures not easily confused with common industrial pollutants.

The national network of stations would collect the raw data on concentrations of the agents in the atmosphere, while transmission and summary analysis of the data could be done within the framework of international exchanges such as now exist through the World Meteorological Organization.

PROPOSAL ABSTRACT G6(G71)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) Short-range sensors - sampling
   b) On-site inspection - selective

3. Source:
   Japan. "Working paper on a biological approach to the question of verification of the prohibition of chemical weapons - organophosphorus chemical agents". CCD/343, 24 August 1971.

4. Summary:

Japanese governmental guidelines for health safety of personnel in plants producing or using organophosphorus compounds have established four criteria for periodical medical examinations:

1) decline in level of cholinesterase in the blood;
2) excessive perspiration;
3) contraction of pupil; and
4) muscular fibrillation of the eyelids and face.

Of these, the first is the most sensitive and is suggested as a possible verification method. Measurement of the activity of cholinesterase in the blood involves relatively simple techniques. The method requires that each worker's blood be tested three or four times prior to commencement of work so that a mean value for normal cholinesterase levels can be established. Thereafter tests every two weeks to two months are conducted depending on the toxity of the pesticide being produced in the plant.

Detection of a significant change in cholinesterase activity would not itself be sufficient to indicate the nature of the chemical compound being produced. Nevertheless, a means of verification such as this one, which covers a wide range of organophosphorus compounds, might be useful.

It might be possible to circumvent detection by this technique by building a plant using optimum safety equipment so that the possibility of employee exposure to the chemicals being produced would be totally eliminated. However, while this might reduce the effectiveness of the biological means of verification, the presence of elaborate safety equipment could itself provide useful verification data.

PROPOSAL ABSTRACT G7(G76)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks

2. Verification Type:
   a) Short-range sensors - seals
   - monitoring devices

3. Source:
   United States. "The use of seals and monitoring devices in CW verification". CCD/498, 29 June 1976.

4. Summary:

Seals and monitoring devices could be used to ensure that moth-balled facilities are not reopened and to assist on-site observers in monitoring destruction of stockpiles. The paper describes several devices:

1) Fibre optic seals:* Such seals must be inspected periodically to detect tampering. Hence depending on the frequency of inspection, a significant period of time could elapse before the tampering was detected. This problem could be overcome if the seal was monitored remotely. A device to do this is being developed. Signals from the device could be transmitted over standard telephone lines or by satellite. The seals would be quite cheap.

2) Cameras: These could be employed to provide continuous observation. For example, closed circuit TV could permit surveillance of areas where there is a toxic hazard. It could also enable one observer to watch several places simultaneously. Development of a tamper resistant system has proven difficult but a prototype exists. The system could include data storage capacity for up to 90 days and a motion detector.

   Alternatively, cameras could be set to run only when triggered by unauthorized activity. A compact tamper resistant camera package has been developed which includes a motion detector trigger. The camera could also be programmed to take pictures at fixed or random intervals. This package can run unattended for 3 months.

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* See also CCD/332, abstract G8(G71).

3) Tamper indicating containers: Such devices would be especially useful in protecting flowmeters. Any penetration of the device leaves indications which are impossible to repair. Fibre optic seals would be used to fasten any openings in the container.

PROPOSAL ABSTRACT G8(G71)

1. Arms Control Problem:
   Chemical weapons - production
   - destruction of facilities

2. Verification Type:
   a) Short-range sensors - seals
   - monitoring devices
   - sampling
   b) On-site inspection - selective

3. Source:
   United States. "Working paper on chemical warfare verification". CCD/332, 5 July 1971.

4. Summary:
   The paper, inter alia, describes certain safety features of a plant producing nerve gases which would be necessary to protect operating personnel. While the presence of these safety features would not constitute certain proof of nerve gas production, nevertheless, their presence would merit fuller investigation to verify that no nerve gases were being produced. These special safety features include the following:
   1) unique design of the plant,
   2) airtight walls and roof,
   3) maintenance of a continuous air pressure differential to prevent leakage,
   4) comprehensive vent controls or a single central vent,
   5) special pumps,
   6) personnel areas that are separated from process areas by airtight barriers,
   7) controls that are located exclusively in personnel areas,
   8) airtight seals, windows, airlocks,
   9) closed circuit TV,
   10) doors without handles on one side,

11) special spray systems,
12) special sample chambers,
13) protective masks and clothing,
14) emergency facilities,
15) automatic gas alarms, and
16) test animals.

The paper continues by listing three ways to dispose of a former nerve gas factory. These are:

1) conversion to peaceful production activities,
2) dismantling, or
3) shutting down pending a decision on final disposition.

The paper proceeds to elaborate on ways of monitoring a shut down facility. Possible monitoring sensors include:

1) Specially sealed containers could be placed a around crucial valves and other equipment. While it would be impossible to ensure that unattended seals were totally inviolable, it is possible to make them highly tamper resistant. Work in this regard has been done in connection with safe-guarding reactors and other nuclear facilities. One method is to seal equipment with fibre optic cables. Such cables have their own unique light "fingerprint" which can be recorded by photographing the polished fibre ends. Any attempt to cut this cable would destroy its "fingerprint". Other methods of indicating tampering are also possible.
2) Seismic sensors could be used to detect the presence of vibrations accompanying production activity.
3) Closed circuit TV.
4) Heat detectors.
5) Automatic sampling techniques could be used in conjunction with alarm systems.

A number of analytical techniques, at various stages of development might be applicable for on-site sampling or in connection to an automatic alarm system. Before using these techniques it would probably be necessary to obtain concentrated samples from air, water or soil near the facility. High levels of purification may also be required. The following techniques are of interest:

1) gas chromatography*,
2) infrared spectrophotography,
3) thin layer chromatography,
4) nuclear magnetic resonance,
5) emission spectrography,
6) electron paramagnetic resonance,
7) colorimetry*
8) enzymatic analysis, and
9) mass spectrometry.

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* See also Japan, CCD/301, abstract B39(G70).

The applicability of many of these techniques for on-site inspection remains to be determined. Factors to be considered include sensitivity, expense, portability, speed and simplicity of operation.

PROPOSAL ABSTRACT G9(G77)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) Short-range sensors - sampling
   b) On-site inspection - selective

3. Source:
   Netherlands. "Working paper concerning the verification of the presence of nerve agents, their decomposition products or starting materials downstream of chemical production plants". CCD/533, 22 April 1977.
   See also: CCD/PV. 748, 28 April 1977.

4. Summary:
   The paper is concerned with verifying the non-production of nerve gases. The method suggested is one of comparing samples of water from upstream and from downstream of a chemical plant. By using gas chromatography, it would be possible to detect the presence of the agents themselves, their waste products or precursors even after extensive water purification. It may also be possible using this method to detect precursors of binary agents. Once a prohibited substance had been detected, an on-site inspection of the plant would be necessary. One advantage claimed for the method is its non-intrusiveness.

   The paper presents a technical discussion of the method using data derived from experiments conducted on the Rhine River. A bibliography is also included.

PROPOSAL ABSTRACT G10(G79)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - production

2. Verification Type:
   Short-range sensors - sampling
   - monitoring devices

3. Source:
   Finland. "Working paper on definitions of chemical warfare agents and on technical possibilities for verification and control of chemical weapons with particular regard to a Finnish project on creation on a national basis of a chemical weapons-control capacity for possible future international use". CCD/381, 27 July 1972.
   See also: - "Working document: Chemical identification of chemical weapons agents - A Finnish project". CD/14, 25 April 1979.
   - CD/PV. 31, 26 April 1979.

4. Summary:

According to Finland in CCD/381, economic records monitoring alone is insufficient to monitor a CW ban. There is a need for additional, generally acceptable, international verification mechanisms. National systems could provide a basis for such an eventual international mechanism.

In CD/14 Finland outlines its research project, which began in 1972, on the verification role of instrumental analysis of CWs. The goal of the project is to create a national CW verification capacity which could be put to international use. Specifically, it is an attempt to develop analytical methods for the detection, in samples, of agents to be prohibited. Organophosphorus agents are focussed upon since there are considered the most potent CWs.

The techniques developed could be useful in three different activities: verification of destruction of stocks, verification of non-production, and verification of alleged use of CWs. The techniques could be of service regardless of the modalities of verification agreed upon. They would be useful for national verification or any combination of national inspection and international elements. They could be useful in connection with an investigation ordered by the Security Council. They could also meet some of the concerns expressed by developing countries about difficulties in carrying out verification using their national means alone.

Finland has presented several working papers since 1972 describing progress and results of the project. These include:

- CCD/412, 14 August 1973,
- CCD/432, 16 July 1974,
- CCD/453, 4 July 1975,

- CCD/501, 2 July 1976,
- CCD/577, 22 July 1978,
- CD/39, 16 July 1979,
- CD/103, 24 June 1980, and
- CD/164, 19 March 1981

In addition, a general review of the most suitable techniques for verification of nerve gas agents was presented in "Chemical and instrumental verification of organophosphorus agents" (Helsinki: 1977).

At present the work of the project is focussed on the following objectives*:

1) development of reliable and standardizable verification procedures which have maximum sensitivity to detect slight traces of the CWs banned (at present the detection limit is one nanogram per litre);
2) preparation of suggestions for standardization of techniques and procedures;
3) preparation of an extensive databank and a handbook for rapid identification of potential CW agents and related chemicals; and
4) development of automated monitoring instrumentation, the use of which may help reduce fear of revealing commercial and industrial secrets.

PROPOSAL ABSTRACT G11(A78)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Short-range sensors - seals

3. Source:
   Ulrich, R.R. Fiber Optic Safeguards Sealing System. Adelphi, Maryland: Harry Diamond Laboratories, 1978. NTIS AD-A052 312.

4. Summary:
   The report describes the progress of continuing research undertaken for the Arms Control and Disarmament Agency of the United States regarding the development of tamper-resistant/tamper-indicating seals intended for arms control applications. The system consists of fiber optic seals and ancillary equipment which assembles, photographs and identifies the seals in the field. The equipment is described, results of preliminary environmental tests are given, and detailed operating procedures are outlined.

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* See: CD/14 and CD/164.

CHAPTER H

REMOTE SENSORS

The use of long-range sensors to monitor activities within a state from outside its borders has been a revolutionary development in the field of verifying arms control agreements. The advent of this technology has greatly reduced the importance of problems arising from the intrusiveness* of many verification activities. Long-range sensors are also extensively used for intelligence gathering purposes, outside the scope of arms control agreements. Their use in this role has, to a large extent, become internationally acceptable, though counter-action to prevent unauthorized observation is presumably equally acceptable. An arms control agreement which relies on remote sensors for verification should therefore include a clause prohibiting a country from interfering with the sensors monitoring the agreement.

Verification of an arms control agreement by use of the remote sensors normally employed for intelligence gathering is often referred to as verification by "National Technical Means". Since virtually all remote sensors are deployed by the superpowers there could be some difficulty in relying on them to monitor a multilateral agreement unless the agreement includes some arrangement for making the information collected by the superpowers available to other signatories, for example through an international agency. Because of some reluctance to divulge what is often considered intelligence information, there is a tendency for the superpowers to favour bilateral arrangements rather than multilateral arms control.

Sensing devices can be termed "remote" in three senses. First, the sensor may be distant from the object it is intended to monitor, while being proximate to the personnel operating it. Shipboard or fixed site radars are an example of such a system. A second situation involves a sensor which is distant from both the object to be monitored and from the personnel controlling the sensor. An observation satellite is an example of this. Finally, a third type of sensor is one which operates in close proximity to the object to be observed while being distant from its controllers. Some of the devices used by the U.S. Sinai Support Mission are examples of this.** For the purposes of this study, the term "remote" will be used to refer to situations where the sensing device and the object to be monitored are distant from each other. Thus, the first two types of sensors described above will come within the scope of this definition. The third type is dealt with in Chapter G.

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* In this case the term "intrusiveness" refers to the physical presence of a monitoring team on the territory of the country being monitored.

** See abstract A12(T75).

The principal agent for remote sensing is the surveillance satellite. There are situations where remote sensors installed in aircraft, ships, or even on land can participate in monitoring an agreement, but this is frequently in a secondary capacity to supplement or enlarge on the satellite observations. In some circumstances, however, aircraft and other remote sensors platforms may constitute a principal element in the verification system. This may be true for regional arms control situations especially for agreements between countries which do not have access to satellites.

With regard to satellites, there are four kinds of missions that have direct relevance to arms control verification:

1) The photographic reconnaissance mission. There are two main types, the "area surveillance" and the "close look" mission. The former involves the use of a wide angle, relatively low resolution camera which is employed to cover large areas and note discrepancies which may need further examination before they can be identified. "Close-look" satellites are directed to the identified areas of interest in order to collect more detailed information. They usually orbit at lower heights than area surveillance satellites in order to obtain more detail, and are consequently relatively short lived. They may also have specialized sensors for different purposes, for example for maritime observation.
2) "Ferret" Satellites. The so-called "Ferret" satellites monitor electronic radiation including radar signals and radio communication. They include both area surveillance and "close-look" types.
3) The early-warning spacecraft. The primary mission of these satellites is to detect the launching of ballistic missiles. To do this they employ infra-red sensors and TV cameras and are usually placed in geo-stationary orbits. Newer versions of these satellites also incorporate nuclear radiation sensors thus taking over the function of the fourth type of satellite considered here which is now obsolescent.
4) Nuclear radiation detection satellites. The function of this series of satellites was to monitor compliance with the Partial Test Ban Treaty by detecting radiation emitted by nuclear explosions in the atmosphere or in outer space.

In addition to the above there are a number of non-military satellites with observational capabilities which might incidentally provide information of value for arms control verification. There are also other developments, notably the "Space Shuttle", which by reducing the costs of launch may ultimately provide the means for orbiting larger satellites with more powerful and reliable sensors.

Because of their crucial military importance the precise capabilities and limitations of surveillance satellites remain a closely guarded secret. However there is some indication that the ground resolution of "close-look" photographic satellites is of the order of one foot, which is good enough to permit the identification of a wide variety of military targets unless they are camouflaged. Photographic surveillance may be limited by darkness and cloud as well as camouflage. This limitation does not necessarily apply to other sensors, though their resolution may be less than that of photographic devices.

One of the major problems with area surveillance is the sheer volume of data involved and the consequent length of time for processing. This could be further increased by the sometimes lengthy interval between two successive looks at the same area necessitated by the orbital characteristics of satellites, visual limitations, and the possibility of interference by the country being observed. This delay may not be important in the case of a long term arms control agreement, but could seriously affect confidence in verification in a situation of near hostilities. Thus in situations where opposing forces are deployed it is frequently desirable to supplement satellite surveillance with long range surveillance from aircraft, ships, or land bases, since such observation can be carried out at the time required, and owing to the presence of human observers can perhaps better circumvent interference with the observation mission.

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H1(G78)
H2(G79)

PROPOSAL ABSTRACT H1(G78)

1. Arms Control Problem:
   Nuclear weapons - research and development

2. Verification Type:
   a) Remote sensors - (Article 2 (1))
   b) Complaints procedure - consultation and cooperation (Article 2 (2))
   - referral to the Security Council (Article 2 (3) and (4)

3. Source:
   Socialist States. "Draft convention on the prohibition of the production, stockpiling, deployment and use of nuclear neutron weapons". CCD/559, 10 March 1978.

4. Summary:
   Article 2 (1) provides a formula for the use of "national technical means of verification... in a manner conforming to the ..... rules of international law". Article 2 (2) provides for consultation and cooperation concerning any problems. Such consultation may be undertaken "through appropriate international procedures within the framework of the United Nations". Furthermore, any party can lodge a complaint concerning suspected violations of the convention with the Security Council (Article 2 (3)). Parties, furthermore are under an obligation to assist the Security Council in any investigation it initiates (Article 2 (4)).

PROPOSAL ABSTRACT H2(G79)

1. Arms Control Problem:
   Nuclear weapons - fissionable materials "cutoff"

2. Verification Type:
   Remote sensors

3. Source:
   Union of Soviet Socialist Republics. CD/PV.38, 3 July 1979.

4. Summary:
   Observance of commitments to cease production and eliminate nuclear weapons calls for extremely effective verification.

This can be based on the use of national means of verification supplemented by well-thought out international procedures. Since measures aimed at halting the production of nuclear weapons and eliminating them will be complex and consist of a number of stages, the form and conditions of such verification must correspond to the objective extent and scope of the measures implemented in each stage.

PROPOSAL ABSTRACT H3(A80)

1. Arms Control Problem:
   Nuclear weapons - fissionable material "cutoff"
2. Verification Techniques:
   a) Remote sensors
   b) On-site inspection - selective
   - IAEA safeguards
   c) Complaints procedure - consultative commission
3. Source:
   Epstein, William. "A Ban on the Production of Fissionable Material for Weapons". Scientific American 243, no. 1 (July 1980): 43-51.
4. Summary:
   The author contends that given the progress made in the past two decades in satellite surveillance and other national technical means, verification of a ban on production of fissionable materials for nuclear weapons no longer presents the same problems in terms of both effectiveness and intrusiveness as was true during the sixties. Modern verification techniques would ensure that large facilities needed to produce significant quantities of enriched uranium and plutonium could not escape detection. Secret diversion of fissionable material to clandestine facilities for production of nuclear weapons would not create any serious instability in the nuclear balance between the superpowers given the magnitude of existing American and Russian stockpiles. Hence, the verification system need not be 100 percent reliable to be effective.
   Special attention concerning verification would have to be given to plutonium production particularly if the world moves towards a plutonium economy involving widespread use of plutonium and breeder reactors for the generation of electricity.
   One solution to this verification problem would be to stop the move toward a plutonium economy. A more feasible approach would be to place all plutonium under IAEA safeguards and all plutonium stockpiles in IAEA custody. This would require strengthening of IAEA safeguards and establishment of special stockpiling facilities. Similar safeguards would be needed for highly enriched uranium produced for special nonexplosive purposes. Full use would also be made of national technical means of verification and of consultative commissions to deal with ambiguous situations.

H3(A80)

Agreement on a successful verification system in the context of a "cutoff" could lead to a significant reduction in tensions between the US and the USSR and would provide a demonstration of international verification useful in other arms control contexts. Once production of fissionable materials for weapons was stopped, future production of this material would only be for peaceful civilian purposes. This development would make it possible for the nuclear-weapons states to accept the same IAEA safeguards required of non-nuclear-weapons states under the Non-Proliferation Treaty, since there would be few military secrets to protect. If this occurs, it would remove one of the irritating features of the NPT for many non-nuclear weapons states - i.e. discrimination in the application of safeguards. Special precautions would need to be taken to prevent secrets about uranium enrichment from being disclosed but these need not be much different from present IAEA precautions to prevent disclosure of the technical and commercial secrets of peaceful nuclear facilities. "If additional verification procedures were required to ensure that uranium-enrichment and plutonium-reprocessing plants in the nuclear-weapons states were not being used to produce fissionable material for nuclear weapons, these procedures would be a necessary concomitant of the great nuclear capabilities of the nuclear-weapons states and would not detract from the essential equity of the treaty, as long as the safeguards on the nuclear weapons states were no less thorough or effective than those on the non-nuclear weapons states". (p. 49)

PROPOSAL ABSTRACT H4(T63)

1. Arms Control Problem:
   Nuclear weapons - partial test ban

2. Verification Type:
   Remote sensors - satellite
   - ground based
   - sampling

3. Source:
   Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space, and Under Water. (The Partial Test Ban Treaty).
   Signed: 5 August 1963.
   Entered into force: 10 October 1963.
   Number of parties as of 31 December 1979: 108.

4. Summary:
   No verification provision is explicitly included in the Treaty. It is implicit that national means are to be used. These techniques mainly involve surveillance by satellite,* air sampling at ground stations to detect radioactive fallout, and other ground based sensors.**

5. Selected Comments of States:
   In CD/PV. 97 (5 August 1980) Sweden referred to the fact that current CTB Treaty negotiations had concentrated entirely on verification of underground nuclear explosions. Since the Partial Test Ban Treaty contained no express verification procedures, Sweden suggested it might be appropriate to consider international verification arrangements for atmospheric explosions as part of a CTB Treaty.

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* In the case of the USA, the Vela series of satellites performed this function until they were discontinued in the early seventies. The task has now been given to a new generation of early warning satellites. The sensors used in this regard include x-ray and gamma ray detectors.

** See Stockholm International Peace Research Institute. Yearbook of Armaments and Disarmament: 1972, Stockholm: Almqvist and Wiksell, 1973, pp. 453-55.

H5(A72)
H6(A61)

PROPOSAL ABSTRACT H5(A72)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   Remote sensors - satellite

3. Source:
   Ølgaard, P.L. "Verifying a Comprehensive Test Ban", Survival 14, no. 4 (July/August 1972) : 162-168.

4. Summary:
   This proposal suggests that a comprehensive test ban could be verified with the use of satellite sensors. Preparatory work connected with clandestine tests, such as the drilling of holes, could be observed from space. The author maintains that even if such a test were conducted in alluvium soil, a medium well suited to absorbing large explosions with minimal observable effects, it would be observable by certain kinds of sensors. Temperature increases at the surface above the explosion would show up if infra-red optics were used, while accidental radioactive emissions would also be detectable.

PROPOSAL ABSTRACT H6(A61)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles

2. Verification Type:
   Remote sensors - satellite
   \- aerial

3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In Arms Control: Issues for the Public, pp. 132-133. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

4. Summary:
   This proposal suggests that an agreement limiting the number of naval vessels that can be away from port at any given time would be an effective means of controlling the total size of the sea-based deterrent force. This, of course, presupposes an accurate initial count of vessels. Such an agreement could be monitored by national means, primarily by satellite and aerial surveillance.

PROPOSAL ABSTRACT H7(G62)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles

2. Verification Type:
   a) Remote sensors
   b) On-site inspection - selective

3. Source:
   United Kingdom. "Preliminary study of problems connected with the verification of the destruction of certain nuclear delivery vehicles". ENDC/54, 1 August 1962.

4. Summary:

It is envisaged that the process of destroying ballistic missiles would be carried out by the country owning the weapons and that the inspectorate would merely need to satisfy itself that the weapons scheduled for destruction had been destroyed. The proposal envisaged here seeks to satisfy this requirement and to preclude the possibility that a nation might replace weapons slated for destruction with substandard weapons. A certain way of ensuring that operational ballistic missiles are destroyed is to fire them on a range and check that they perform as expected and fall within some prescribed area. This would make divulging precise details of missile construction unnecessary. If the flights were pre-announced, the destruction process could be verified by nonintrusive national means.

Alternatively, it would be possible to establish "demolition factories" where certain missile components could be destroyed under international supervision. In this case, however, to ensure that the missiles scheduled for destruction were not sub-standard, it might be necessary to establish "test centres" at which the highly specialized navigation and control equipment removed from the missile could be tested for accuracy and then destroyed or salvaged for civil use.

This latter system would require an inspectorate to be made up of technicians capable of carrying out the tests. The UK suggests that in the case of an inertially-guided missile, about 1½ - 2 man weeks would be required to check the navigation system of the missile. Supervisors would also be required to monitor the destruction process, perhaps a dozen at each centre. Clerical staff might bring the total staff up to 100 per factory.

H8(A73)

PROPOSAL ABSTRACT H8(A73)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles

2. Verification Type:
   Remote sensors - satellite

3. Source:
   Greenwood, T. "Reconnaissance and Arms Control". Scientific American 288, no. 2 (February 1973): 14-25.

4. Summary:

A series of satellite reconnaissance techniques provide a good deal of assurance that clandestine production of missiles could be detected. Area surveillance by observation satellites of objects such as transportation networks, power generation plants and manufacturing facilities could detect suspicious activities. Uncertainties raised in this way could then be investigated by high resolution photography, and by infra-red and multi-spectral sensor techniques. These last techniques are capable of providing a great deal of information about activities carried out inside buildings or under other coverings. Combined with observable changes in standard operating procedures, it is often possible to gain a good idea of important new developments.

PROPOSAL ABSTRACT H9(A76)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors

3. Source:
   Lodal, Jan M. "Verifying SALT". Foreign Affairs 24 (Fall 1976): 40-64.

4. Summary:

Lodal reviews charges that the Soviet Union has cheated on its obligations under SALT I and concludes that the evidence does not support the view that the USSR has cheated, that they are unreasonably pushing the limits of the agreements, that they are attempting to exploit "loopholes" or that US verification capabilities are inadequate.

Verification problems for SALT II will be greater than for SALT I. This is especially true of proposed MIRV limits. In the case of certain Soviet MIRVed missiles, monitoring the unique command, control and support facilities can permit verification of numerical limitations. In the case of other missiles a "typing" rule might be applied: if any missile is developed in both a MIRVed and unMIRVed mode, then all such missiles will be counted as MIRVed regardless of which version is deployed.

A less difficult problem of MIRV verification concerns distinguishing between two missile launchers (especially on submarines) which are identical except that one contains a MIRVed missile while the other does not. Employing a "typing" rule would be inconsistent with US deployment of Minutemen IIs and IIIs. Lodal suggests instead applying "typing" rules to classes of SLBMs and mobile ICBMs and also declaring which ICBM silos are unMIRVed.

Counting the number of strategic delivery vehicles generally will not pose problems except in the following instances. Mobile land-based ICBMs, especially if deliberate concealment is involved as in a "multiple aim point" system, will present verification difficulties. Lodal suggests agreeing to keep the numbers of such missiles low. Another problem will arise regarding distinguishing mobile IRBMs from mobile ICBMs. Lodal suggests agreement that any mobile launcher capable of launching an ICBM be "typed" as an ICBM. Finally, counting problems might arise for "bomber variants" such as tanker and maritime patrol aircraft, the Backfire bomber and air-to-surface ballistic missiles (ALBMs). Lodal does not see these verification problems as serious, however.

Verifying limits on cruise missiles will be difficult. There are three likely problems here: determining the range of a particular missile, counting the number deployed and distinguishing nuclear and non-nuclear versions. To reduce these verification difficulties Lodal suggests that a single range limit apply to all types of cruise missiles (ALCMs, SLCMs, and ALCMs) and that above this limit all cruise missiles would be banned.

While verification of SALT II will not be certain, this must be balanced against other factors. First, no undetected Soviet cheating would make a significant difference strategically. The Soviets therefore would have little motivation to cheat. Finally, the value of SALT II outweighs verification problems.

Lodal also discusses the ambiguous impact of technological improvements on verification. On the one hand, "national technical means" can be expected to become increasingly better. More frequent and reliable electronic and photographic data will be available. Combinations of methods will improve surveillance further. On the other hand, improved technology will permit easier evasion of NTMs. These improvements include encryption, shielding, decoying and spoofing.

Lodal also addresses verification of agreements on the reduction of strategic armaments. He feels that the US could easily verify such reductions in numbers but the lower force levels shrink, the more important verification will become since a small amount of cheating could make a significant different strategically.

Regarding qualitiative limitations on strategic arms such as accuracy of missiles, Lodal does not have much confidence in the verifiability of such agreements. On-site inspection except of the most intrusive kind would have little value.

PROPOSAL ABSTRACT H10(A79)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors - satellites
   - aerial
   - shipboard
   - radar

3. Source:
   Aspin, Les.* "The Verification of the SALT II Agreement". Scientific American 240, no. 2 (February 1979): 38-45.

4. Summary:

According to Aspin, verification is the keystone of any international arms control agreement. There are three levels of confidence concerning the ability of the US to detect violations of SALT II. First, there are numerous cheating methods for which the verification capabilities of the US are excellent, rendering the possibility of successful evasion by the USSR remote. This level of confidence applies to all the areas in which major violations of SALT II could upset the strategic balance. Second, there are several areas where the verification capabilities of the US are quite weak but in all these cases cheating would not have militarily significant results. Third, there are a few areas where serious verification problems will arise at the next stage of SALT. This is the case for cruise missiles and transferable MIRV payloads.

Total launchers:

Regarding a ceiling on the total number of strategic launchers, there are three methods of evasion open to the USSR. The first is deployment of new types of strategic weapons. Building a new strategic weapon system involves at least five stages: research, development, testing, production and deployment. The US ability to detect clandestine activity during any of these phases ranges from fair to excellent. For the first phase alone the US has several ways of monitoring the USSR including: line-of-site and OTH radars, early warning satellites, and ship and aircraft based sensors.

The second evasion method is deploying additional weapons of existing types. Monitoring this is more difficult than for the first cheating method, but still is very good particularly regarding production and deployment of missile carrying submarines and bombers. For ICBMs, while construction of new silos and associated command-and-control systems can be detected, small-scale violations might be hard to identify primarily because of the time it takes to process satellite data.

* US Congressman.

H10(A79)

The third cheating method is conversion of nonstrategic weapons into strategic ones. There are substantial verification problems in this area. Regarding upgrading of the Backfire bomber into an intercontinental system, several aspects would be detectable including production, deployment, and training for in-flight refueling. The most difficult element is verifying the plane's characteristics, specifically its range and payload; cheating here could go undetected.

Regarding upgrading of the SS-20 (IRBM) into an SS-16 (ICBM) configuration, testing of the new system would be required which could be detected. Furthermore, testing of the SS-16 has been banned by SALT II.

Finally, regarding the possible reconfiguring into bombers of about 100 Soviet anti-submarine and reconnaissance aircraft, only a few would escape detection.

MIRVs and ALCMs:

There are also restrictions in SALT II placed on MIRVs and ALCMs regarding which there are four methods of evasion possible. The first is by constructing new silos and submarines for MIRV'd vehicles. Such construction however could be readily detected. Second, MIRV'd missiles might be substituted for unMIRV'd ones in existing launchers. Verification in this case requires that the US know which Russian missiles are MIRV'd and which launchers contain which missiles. To aid in this situation SALT II incorporates "typing" rules by which all missiles of a type that has been tested in a MIRV'd mode or been fired from a launcher with a MIRV'd warhead are counted as MIRVs. In addition, the US can detect which Russian silos and which Russian submarines contain MIRV'd missiles because of their unique characteristics.

The third way of cheating is to replace the warhead on an unMIRV'd missile with a MIRV payload. This would be very hard to detect but at present no such transferable warheads exist.

The fourth cheating method involves placing ALCMs on additional bombers. Presently, Russian cruise missiles must be externally mounted on bombers so the US can monitor their numbers. Modifications to aircraft to permit internal mounting would be detectable. For internally mounted ALCMs, use of "typing" rules for ALCM capable bombers could be helpful. An additional problem concerns the range of the cruise missile. At present there is no systematic way of verifying the range of a cruise missile. Similarly, there is no way of distinguishing nuclear-armed cruise missiles from conventionally armed ones.

SALT II also prohibits "rapid reload" systems. These can be verified by satellite since large equipment is needed for such a capability as well as extensive training.

Protocol:

The Protocol bans deployment and testing of mobile ICBMs. There is no question the US can detect deployment of such a system but determining the actual numbers could be difficult. The Protocol also prohibits testing and deployment of GLCMs and SLCMs with a range of more than 600km. This is not verifiable. However, evasion here would present no threat before the Protocol expires.

In addition to the surveillance methods discussed above the US has other intelligence gathering methods including monitoring of internal communications and fortuitous sources such as defectors. The potential for violations is also reduced because of the degree of skill and luck demanded of the violator if he is to succeed in evading detection. Experience with SALT I has also demonstrated the powerful verification capabilities of the US.

It is questionable, as well, whether there would exist real motivation for the USSR to cheat. First, SALT II provides great scope for both sides to pursue strategic programs without cheating. Second, should the USSR become dissatisfied with SALT II it has other alternatives, such as renegotiating or withdrawing from the Treaty. Third, the USSR would face severe political repercussions if caught cheating.

In the final analysis, the real danger from violations of SALT II would arise only if there were a significant military advantage to be gained by cheating. But, even if the Russians successfully cheated in every way that might escape detection, they would add little to their strategic power and might even reduce their strength in some areas because of transfer of weapons systems from a regional mission to an intercontinental role.

H11(T79)

PROPOSAL ABSTRACT H11(T79)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   a) Remote sensors - aerial
   - ground based
   - satellite
   - shipboard
   b) Complaints procedure - consultative commission
   c) International exchange of information

3. Source:
   a) Treaty between the United States of America and the Union of Soviet Socialist Republics on the limitation of strategic offensive arms (to be in force until 31 December 1985).
   b) Protocol (to be in force until 31 December 1981).
   c) Ancillary Agreed Statements and Common Understanding.
   d) Joint Statement of Principles and Basic Guidelines for Subsequent Negotiations on the Limitation of Strategic Arms.
   (SALT II).
   Signed 18 June 1979.
   See also: United States. Department of State. Bureau of Public Affairs. Verification of the SALT II Agreement. Special Report #56. Washington, D.C.: August 1979.

4. Summary:

SALT II involves a complicated framework of restrictions on several strategic nuclear weapons systems. The principal methods of verification specified are "national technical means" (Article 15 (1)) which are to be used in accordance with generally recognized principles of international law. In an agreed glossary attached to the Treaty, NTMs are defined as "assets which are under national control for monitoring compliance with the provisions of an agreement. NTM include photographic reconnaissance satellites, aircraft-based systems (such as radars and optical systems) as well as sea- and ground-based systems such as radars and antennas for collecting telemetry". Each party also undertakes not to interfere with the NTMs of the other (Article 15 (2)) and not to use deliberate concealment measures to impede verification by NTMs (Article 15 (3)).

The foregoing provisions are similar to those of SALT I. In contrast to SALT I, however, the superpowers have agreed to more precise definitions of concealment and incorporated these into the SALT II framework in the form of Agreed Statements and Common

Understandings. These include the following:

a) The ban on concealment applies to testing, including the concealment of the association between ICBMs and launchers during testing.

b) The ban also extends to methods of concealing transmission of telemetric information during testing including encryption when it impedes verification of the treaty. Encryption is defined in the Glossary to SALT II as coding communications for the purpose of concealing information.

c) The ban includes shelters over ICBM silo launchers that impede verification.

The careful definition of the weapons systems and activities subject to restriction under SALT II has also been dictated by the requirements of verification using NTMs. In particular mention should be made of "Functionally Related Observable Differences" (FRODS) and "Observable Differences" (ODS) which are criteria established for distinguishing between those weapons systems which are capable of performing functions banned under SALT II and those systems which are not.

Also relevant to verification is the practice incorporated into SALT II of "typing" various missiles or launch systems whereby the parties agree that once a system has demonstrated a capacity to be used in a certain configuration (such as in a MIRVed mode), then it will be assumed for purposes of counting that all the individual missiles or launchers of that system are, in fact, in that configuration (i.e. all are MIRVed). In other words, it is not necessary to try to distinguish between different variations of the same missile (such as one which is MIRVed and one which is not) which would complicate verification considerably.

The SALT II Agreement also provides for the continued use of the Standing Consultative Commission established in a Memorandum of Understanding of December 1972 as a follow-on measure to the SALT I treaties. The Commission's functions are somewhat expanded, however, to make the body into a forum for the following:

a) Agreement on procedures for replacing, converting, dismantling or destroying strategic arms in cases provided for in the provisions of SALT II and on procedures for removal of such arms from the aggregate numbers when they otherwise cease to be subject to the limitations specified in SALT II. At regular sessions of the Commission parties are to notify each other in accordance with the aforementioned procedures, at least twice annually, of actions completed and those in progress (Article 17 (2e)),

b) Consideration of proposals for further measures limiting strategic offensive arms (Article 17 (2g)).

Also, under Article 17 (3) the Commission is given the responsibility for maintaining an agreed data base on numbers of strategic offensive arms established as part of SALT II by a Memorandum of Understanding of 18 June 1979. In an Agreed Statement the Parties specify that the data base is to be updated at each regular session of the Commission through the notification by each Party of any changes to the categories established by SALT II. As part of the SALT II package both sides provided "Statements of Data on the Numbers of Strategic Offensive as of the Date of Signature of the Treaty", which are to constitute the basis of the aforementioned data base.

Other forms of information exchange are also incorporated into the Treaty to assist verification. These take the form of prior notifications of events, usually through the Consultative Commission. Among these are the following provisions for notification:

a) Future types of heavy bombers (Article 2 (3) and the Second Agreed Statement).
b) New types of MIRVed SLBMs when first installed on a submarine (Article 2 (5) and the Second Agreed Statement).
c) Plans to flight test unarmed pilotless guided vehicles with a range greater than 600 km. (Article 2 (8) and the Fifth Common Understanding).
d) The first and last test launches of the new type of ICBM which each party is permitted to develop (Article 4 (9) and the Second Agreed Statement).
e) The number of ALCM test planes (Article 7 (1) and the Second Common Understanding).
f) New ICBM test ranges (Article 7 (2) and the Second Agreed Statement).
g) ICBM test launches which extend beyond the territory of the party and all multiple test launches of ICBMs (Article 16 (1)).

Such notifications presumably will allow the other party to concentrate its NTMs on the activity.

Finally, in the 'Joint Statement of Principles and Basic Guidelines for Subsequent Negotiations on the Limitation of Strategic Aims' both sides have agreed that further limitations and reductions must be subject to adequate verification by NTMs using also, as appropriate, cooperative measures contributing to the effectiveness of verification by these means. The parties are also committed to strengthening verification and perfecting the Standing Consultative Commission.

5. Selected Comments of States:

The US government addresses the verification of SALT II in a US State Department publication entitled Verification of the SALT II Agreement. This document states the criteria which the US employs to determine adequacy of verification as the following:

a) the capabilities of existing and projected intelligence collection systems and analysis techniques,
b) the measures the Soviets could take to evade detection,
c) the costs and risks to the Soviets of any attempt to evade the limits,
d) the military significance of potential violations,
e) the capability of the US to offset the effects of potential Soviet noncompliance and carry out appropriate and timely responses if violations are discovered, and
f) tradeoffs of verification considerations in order to allow

US flexibility in its own weapons programs.

The paper concludes that the US government is confident of its ability to adequately verify the agreements.

PROPOSAL ABSTRACT H12(A79)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles.

2. Verification Type:
   a) Remote sensors
   b) On-site inspection - selective
   c) Short-range sensors - monitoring devices

3. Source:
   Garn, Jake*. "The SALT II verification myth". Strategic Review (Summer 1979): 16-23.

4. Summary:

US ability to verify SALT II is limited to national technical means. There are major gaps in American NTM resulting from loss of US facilities in Iran, betrayal of information on US reconnaissance satellites to Soviet agents, encryption of Soviet telemetry and budget cuts. There is some redundancy in US capabilities but the loss of a single system can leave a gap.

The US government has failed to respond to extensive Soviet violations of SALT I which is essential to the success of the deterence role of verification. Given these past violations Garn contends that the US can not expect Soviet cooperation regarding verification of SALT II. SALT II will legitimize Soviet encryption of telemetry and the US will be unable to distinguish legitimate from illegitimate encryption.

The qualitative restrictions of SALT II such as those on throw-weight and missile size cannot be adequately verified. There is therefore a potential for Soviet clandestine missile deployment. Nor can the capabilities of bombers and the range of cruise missiles be monitored.

Garn recommends as a minimum step that the US seek to enhance the status and powers of the Standing Consultative Commission to enable it to implement cooperative US-USSR verification measures including a provision allowing for "no-notice" on-site inspection. Moreover each nation could agree to the installation on its territory of several monitoring sites operated by the other nation.

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* US Senator.

PROPOSAL ABSTRACT H13(A79)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned bombers
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors

3. Source:
   Milburn, Thomas W. and Kenneth H. Watman. "SALT II: Verification". Mershon Centre Quarterly Report 4, no. 4 (Summer 1979).

4. Summary:

This paper, based on open sources, reviews American verification capabilities and their use for monitoring SALT II. Four verification "principles" are identified:

1) verification is a substitute for trust,
2) adequacy,
3) relevance, and
4) standard of evidence is less than beyond reasonable doubt.

Sensor technology is then reviewed and its utility for SALT including:

1) x-ray and gamma ray detectors (not useful),
2) ultra violet detectors (some value for missile launchers),
3) visible spectrum detectors (highly useful),
4) infra-red detectors (highly useful),
5) radar (highly useful), and
6) radio frequency detectors (highly useful).

US observation satellites and missile test surveillance capabilities are examined. Finally, the verification of specific SALT II provisions is assessed. While this paper provides little original information, it is a useful summary of several other articles in the open literature.

PROPOSAL ABSTRACT H14(A80)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors - ELINT
   - ground based
   - radar
   - satellites
   - shipboard

3. Source:
   Stockholm International Peace Research Institute. World Armaments and Disarmament Yearbook: 1980. London: Taylor & Francis, 1980, pp. 29[illegible]-312.

4. Summary:

This chapter from the SIPRI Yearbook evaluates the verification system intended for SALT II. It points out that respecting qualitative data about weapons systems, the major activity that will have to be verified is flight testing of ballistic missiles since this is the only time such factors can be observed remotely. The discussion then focuses on describing the present ballistic missile test ranges of both the USA and USSR and the capabilities each has of monitoring the other's tests. For the US a variety of remote sensing systems are used including:

- communications and telemetry interception equipment,
- radars (OTH and line-of-sight), and
- acoustic sensors.

Satellites, ships and land installations are all used in monitoring adversary flight tests. The SIPRI chapter concludes that the US has excellent resources for terminal phase monitoring of Soviet flight tests which is where most important data is revealed. This ensures that the most important stipulations in the treaty can be effectively verified.

Cruise missile testing poses a greater verification problem than for ballistic missiles from the US point of view because Soviet test ranges are outside the range of most US remote sensors.

Deployment of these strategic weapons systems is monitored mainly by satellite. A brief discussion of the capabilities of photographic reconnaissance satellites is included.

The possibility of a strategic "breakout" - that is, creation of a strategic military advantage through the clandestine production or stockpiling of weapons which could quickly be prepared for

operational use - is also addressed. SIPRI concludes the various scenarios suggested for such "breakouts" are unlikely to occur.

Also presented is a useful table (pp. 304-308) which lists the aspects of SALT II requiring verification together with SIPRI's assessment of the verification techniques which will be used to monitor these restrictions. The SIPRI authors point out that, according to their table, there is at least one verification resource for virtually every verification requirement.

In the view of the SIPRI authors, the most serious verification problems may arise for ICBM modernization programs together with the development of the new type of ICBM permitted under the Treaty both of which require surveillance of missile flight tests. "The requirements of this task are known to be at the brink of the technical capabilities of existing verification systems" (p. 310). Additional problems could arise because of concealment or encryption of telemetry during tests. While this is generally banned by SALT II, the treaty does not specify which transmissions should not be encrypted. SIPRI feels however that in practice this will not be a serious problem. Any encryption or concealment will be readily apparent and would be raised in the Standing Consultative Commission. Because test programs require 20-30 tests over several years successful concealment would be very difficult.

Both governments seem to be satisfied that the verification system incorporated into SALT II will give them warning of any violation before it could pose a serious military risk.

PROPOSAL ABSTRACT H15(A80)

1. Arms Control Problem:
   Nuclear weapons: - ballistic missiles
   - missile tests
   - reentry vehicles

2. Verification Type:
   Remote sensors - ground based
   - satellite

3. Source:
   Aspin, Les, and Fred M. Kaplan.* "Verification in Perspective". In Verification and SALT: The Challenge of Strategic Deception, pp. 177-190. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.

4. Summary:
   The authors address themselves to four areas of concern regarding verification of SALT II. First, can restrictions on missile launch-weight and throw-weight be verified? They conclude that even without Iranian listening posts the US can keep track

* US Congressman and (his) legislative assistant, respectively.

of significant changes in Soviet missile fuel type, throw-weight and, to a lesser extent, launch-weight. The Soviets, clearly, might be able to make modest changes in throw weight beyond SALT limits without US detection but if they tried to exploit this additional weight in any militarily meaningful manner their efforts would almost certainly be discovered. In addition to this lack of incentive for the Soviets to cheat, the uncertainties involved in verification of this provision create fewer and smaller risks than would exist for the US without SALT II.

The second verification problem discussed is telemetry encryption. SALT II includes provisions against encryption which impedes verification. In the event of encryption of any data, it would be possible to determine whether the information being hidden was important for verification. Other cheating strategies are examined by the authors and they conclude that they are not very serious threats. Also, SALT II requires that the Soviets make available far more data than they would otherwise.

The third verification question is whether the US can verify the number of warheads on heavy missiles particularly the SS-18 which has apparently been tested to release 12 reentry vehicles instead of the 10 which would be permitted under SALT II. The authors contend that the number of tests so far is insufficient for operational deployment of this configuration of the SS-18. In addition, even assuming the SS-18 can carry 12 warheads this is preferable to the 25 possible without SALT II.

Finally, the authors address themselves to the possibility of the Soviets covertly stockpiling ICBMs. There are a number of difficulties with this scenario according to Aspen and Kaplan. They conclude that the uncertainties involved with respect to missile stockpiling under SALT II create fewer and less serious risks than those the US would face without the treaty.

PROPOSAL ABSTRACT H16(A80)

1. Arms Control Problem:
   a) Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

   b) Regional arms control - outer space

2. Verification Type:
   a) Remote sensors - aerial
   - ELINT
   - ground based
   - radar
   - satellite
   - shipboard

3. Source:
   Blair, Bruce G., and Garry D. Brewer. "Verifying SALT Agreements". In Verification and SALT: The Challenge of Strategic Deception, pp. 7-48. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.

4. Summary:
   This is a very thorough, comprehensive and up-to-date review, based on unclassified sources, of current technical means of verification available to the US for monitoring SALT agreements.

   The authors include in their review a brief recollection of Soviet-US verification experiences since the Second World War. They claim that this history supports the view that verification is the key to the success of SALT.

   After a brief summarization of the provisions of the SALT II treaty, the authors discuss several assumptions that have a bearing on the issue of verification. For example, they point out that:

   1) flight testing new ballistic missile systems seems likely to be a part of the development of that system,
   2) the sensitivity of satellite sensors are expected to vastly improve over the next 20 years,
   3) strategic weapons need not be kept under continuous surveillance to assure compliance with SALT,
   4) verification is not simply a technical question; judgement, analysis and inference all weigh heavily in the process, and

5) reliance on multiple monitoring systems will continue to play a major role in SALT verification.

A highly detailed review of current American verification capabilities follows. First, satellite platforms and sensors are examined. The authors claim that the resolution of "close look" satellite photography is now in the order of three or four inches which is probably the limit allowed by the atmospheric scattering of light caused by turbulence and pollution. They also present tables indicating the target resolution required for the verification of different weapons systems. Also discussed are the limitations on satellite sensors including cloud cover, darkness, time over the target, timeliness of data, and camouflage. Their discussion covers satellites other than photographic reconnaissance ones as well as a variety of sensor systems.

Next, the authors consider data transmission and analysis. They point out the need to use computers in analyzing the data obtained from sensors and the concern which has arisen about the lag between the capability to generate data and the capability to analyze it in a timely fashion.

American ground sites are then examined, particularly radar and electronic listening stations used to monitor Soviet missile testing. This discussion includes an assessment of the impact of the loss of Iranian-based posts. They conclude that US ground sites can still monitor Soviet compliance with flight test restrictions with a high-degree of success. However, while the US will continue to be able to monitor Soviet flight tests during reentry and splashdown, its ability to monitor telemetry and other characteristics during the early stages of tests appears to be "borderline for verification purposes" (p. 33).

The role of aircraft and ships in US verification capabilities is next reviewed. Both play important roles. The US ability to monitor antisatellite testing agreements is then examined. The focus here is on the North American Air Defense Command's space tracking system. Again the discussion includes consideration of present capabilities and future developments.

In addition to the above methods, the authors also discuss briefly other means of obtaining verification information. They mention "ferret" electronic intelligence satellites, reconnaissance submarines and sophisticated sensors hidden inside the territory of potential adversaries or on the adjacent sea floor. These sources of intelligence, the authors feel, may not be legal and thus remain outside the provision in the SALT agreements preventing interference with national technical means which are used in a manner consistent with international law.

While technical information is more reliable generally than nontechnical information, as new arms control agreements become harder to verify using technical means, the value of espionage and other covert activities may have to be reconsidered. While the US should not rely on these methods, they should not be dismissed out of hand.

Finally, the authors point out the role of the Standing Consultative Commission. The intent of this body is that both sides are committed to providing clarifying information to the queries of the other.

Blair and Brewer also include at the end of their paper an assessment of US capabilities for monitoring controls on anti-satellite warfare activities, controls which they claim deserve high priority. US satellite surveillance is good up to 3000 miles and activities in deeper space can be monitored fairly well today. Within ten years new ground and space-based sensors will permit reliable monitoring of a variety of antisatellite activities.

PROPOSAL ABSTRACT H17(A80)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors - satellite

3. Source:
   Cohen, Stuart A.* "The Evolution of Soviet Views on SALT Verification: Implications for the Future". In Verification and SALT: The Challenge of Strategic Deception, pp. 49-75. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.

4. Summary:
   The author reviews Soviet public commentary on the issue of SALT verification in an attempt to establish the views of the Soviet government. Several observations about Soviet views are made including:
   1) Initially all satellite reconnaissance was considered illegal by the Soviet government.
   2) Presently at least some satellite and ground-based reconnaissance is considered legal.
   3) Some forms of nonreconnaissance satellite-borne activity are today considered illegal.
   4) A Soviet controlling organization and a weapons development program for interference with satellites exist.

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* Senior analyst with the National Foreign Assessment Center of the US Central Intelligence Agency. The article includes a note that the views expressed in this chapter do not represent those of the CIA.

5) Some camouflage, concealment and deception in the context of strategic weapons is not perceived to be prohibited by existing arms control agreements.
6) It is difficult to determine how the Soviet distinction between legitimate and illegitimate reconnaissance and between licit and illicit camouflage can be operationalized.
7) Despite movement on the issue it is wrong to suggest blanket approval of US reconnaissance activities has occurred.

PROPOSAL ABSTRACT H18(A80)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors

3. Source:
   Humphrey, Gordon J.* "Analysis and Compliance Enforcement in SALT Verification". In Verification and SALT: The Challenge of Strategic Deception, pp. 111-127. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.

4. Summary:
   The author contends that US faces three verification problems: declining intelligence collection capabilities in the face of more challenging monitoring requirements, faulty analysis, and declining US will to challenge Soviet activities and enforce Soviet compliance. He claims that the "compromising" of two American satellite collection systems by Soviet espionage, the loss of Iranian-based listening posts and budget restraints have resulted in a cutback in technical collection capabilities. He reviews Soviet compliance with the SALT I Accords contending that the Soviets were guilty of several violations and claiming that both evidence and analyses of these have been suppressed by the US government.

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* US Senator.

PROPOSAL ABSTRACT H19(A80)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   Remote sensors

3. Source:
   Katz, Amrom H. "The Fabric of Verification: The Warp and the Woof". In Verification and SALT: The Challenge of Strategic Deception, pp. 193-220. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980
   See also: Verification and SALT: The State of the Art and the Art of the State. Washington, D.C.: Heritage Foundation, 1979.

4. Summary:
Katz contends that US intelligence services and the Soviet Union have existed in a symbiotic relationship. To be effective for deterrence, a weapons system must be known to the other side. The Soviets have used US intelligence as a route for disclosing their capabilities. They have done this merely by not being excessively "noncooperative". The question therefore remains, according to Katz, as to how good is US intelligence if the Soviets are motivated to cheat. He reviews several reasons why they would and several methods by which they could cheat. He concludes that the capability of US intelligence to monitor covert deployments is uncertain and calls for a review of US abilities in this regard by an interagency group not involved in the SALT negotiations.

PROPOSAL ABSTRACT H20(A80)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - cruise missiles
   - manned aircraft
   - missile tests
   - mobile ballistic missiles
   - reentry vehicles

2. Verification Type:
   a) Remote sensors
   b) On-site inspection - selective

3. Source:
   Kruzel, Joseph J. "Verification and SALT II". In Verification and SALT: The Challenge of Strategic Deception, pp. 95-110. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.

4. Summary:

The author distinguishes between "monitoring" (i.e. "using intelligence capabilities to find out what the other side is or is not doing, first by collecting and then by evaluating new intelligence" (p.96)) and "verification" (i.e. "determining the adequacy of a nation's capability to monitor compliance" (p.96)). To monitor SALT II the US will use NTMs. It appears to have abandoned its long attachment to on-site inspection which would be of little benefit in monitoring most provisions of the treaty. NTMs will also avoid the complexities of an on-site system, they can be unilaterally deployed and controlled, they are unobtrusive and the data they provide are accessible and reliable.

The essence of monitoring is determining some level of confidence in detecting a violation. The author presents the US views on what this level should be. Also included is a discussion of the impact of the loss of Iranian-based monitoring facilities.

Concerning "verification" the author discusses Soviet incentives to violate the treaty and the possibilities of covert deployment of strategic weapons by them. He also emphasizes the importance of reaction to suspected violations. The author concludes that the SALT II verification meets the standard of "adequate verification".

PROPOSAL ABSTRACT H21(A81)

1. Arms Control Problem:
   Nuclear weapons - ballistic missiles
   - missile tests
   - reentry vehicles

2. Verification Type:
   Remote sensors - aerial
   - ELINT
   - ground based
   - radar
   - satellite
   - shipboard

3. Source:
   Hussain, Farooq. The Future of Arms Control: Part IV, The Impact of Weapons Tests Restrictions. Adelphi Papers #165. London: International Institute of Strategic Studies, 1981.

4. Summary:

Hussain gives a thorough and up-to-date review of modern techniques for monitoring missile flights. He divides these techniques into four categories: radars (both land- and ship-based), satellites, aircraft overflying impact areas and electronic intelligence obtained from telemetry interception. Each of these categories are discussed in detail, outlining their missions, capabilities and limitations. The emphasis is on US monitoring resources though some discussion of Soviet systems is included. Of particular note is Hussain's discussion of encryption and the vital importance of telemetry monitoring for verifying that new modifications and new equipment are not being tested. By their nature telemetry transmissions are highly susceptible to cheating regardless of whether encryption is used.

In general Hussain concludes that while it is relatively simple to detect missile test launches with a high degree of assurance, it is much more difficult to monitor whether the flight is being used to upgrade the missile, its reentry vehicles or one of its subsystems. Present monitoring techniques have been able to observe a wide variety of qualitative improvements in ballistic missiles but this is more due to the fact that there has been little incentive to conceal these developments than to increased capabilities of the monitoring systems. It is also very unlikely that technical refinements of missile test monitoring methods will overcome the difficulties discussed in the paper.

A tight agreement to prevent any significant violation would require exhaustive definition of possible evasion methods and careful drafting to prevent them as well as redundant verification techniques some of which would be highly intrusive. This would lead to a fractious negotiating process overemphasizing technical

details. Past experience with SALT suggests as well that failure to detect violations is less a problem than knowing how to respond to a specific violation. The confidence building benefits of a flight test agreement could easily be outweighed by these problems created by the need for verification.

On the other hand, violations, however technical, help undermine the perceived value of the arms control measure and the scope for technical violations is likely to be larger under test restriction agreements. Another disadvantage of flight test restrictions is that they may encourage development of alternative methods for evaluating strategic weapons which would be unverifiable.

PROPOSAL ABSTRACT H22(A79)

1. Arms Control Problem:
Nuclear weapons - mobile ballistic missiles

2. Verification Type:
Remote sensors

3. Source:
Drell, Sidney. "SUM". Arms Control Today 9, no. 9 (September 1979): 1-3.

4. Summary:
The author proposes the use of Shallow Underwater Mobile (SUM) basing scheme for the American MX missile. This would involve carrying the missiles on small conventionally powered submarines which would operate within several hundred miles of the US coasts.

Verifying SUM would simply involve an extension of procedures presently used to check SLBM deployment. This contrasts with the verification difficulties of the Horizontal Dash basing mode for the MX. In the latter configuration there is a conflict between maintaining security of the system and verifying the actual numbers of deployed missiles. Resolving this conflict using NTMs will require considerable cooperation between the two superpowers. At the least, there will need to be agreement on special procedures and locations for introducing one missile and no more on each track.

H23(A79)

PROPOSAL ABSTRACT H23(A79)

1. Arms Control Problem:
   Nuclear weapons - mobile ballistic missiles

2. Verification Type:
   a) Remote sensors - satellites
   b) On-site inspection - selective
   c) Short-range sensors - monitoring devices

3. Source:
   Meyer, Stephen M. "Verification and the ICBM Shell-Game". International Security 4, no. 2 (Fall 1979): 40-68.
   See also: Idem, "MAPS for the MX Missile". Bulletin of the Atomic Scientists (June 1979): 26-29.

4. Summary:

The focus of these articles is on the verification difficulties raised by deployment of mobile land-based missiles in a Multiple Protective Structure (MPS) basing scheme. The objective of such a basing system is to increase the number of points which an adversary must target by constructing numerous extra missile silos or shelters ("aim points"), all of which could house ICBMs but only a few of which actually would. The key to the success of such a system is that the opponent be unaware of which shelters house the missiles at any particular time, forcing him to target all of them.

For the purposes of his examination, Meyer uses the following hypothetical case: an MPS system of 250 squadrons, each squadron having 20 protective structures, one ICBM in a canister launcher, one transporter emplacer vehicle, 19 simulator packages and a service-support area. Each squadron would be located in an area of 20-60 square miles. According to the author, a different method of multiple basing such as a trench shuttle system will face verification problems similar to those of the above. For his analysis Meyer assumes that the USSR will follow the lead of the US in developing such an MPS system.

Using this case the author examines four basic approaches to verifying the number of ICBMs in a MPS configuration. The first method is monitoring the production of the special canister launchers to ensure that a significant number of extra launchers are not produced. Meyer concludes that such monitoring would require continuous observation which rules out non-stationary satellites. Geosynchronous satellites do not have the necessary resolution so they must be ruled out also. He suggests that on-site systems (black-box technology and human visits) at production choke-points might be one way of verifying production, however this does not eliminate the possibility that undeclared production facilities could be built. He raises two questions in this context: could such intrusive on-site verification be negotiated and would NTMs be capable of detecting undeclared facilities?

The second general verification approach is to monitor the production of the missiles to be used in the MPS system. This approach has problems similar to those concerning monitoring canister launcher production. In addition, however, in the case of a Soviet MPS, Meyer contends that use of an undeclared production facility would be easier since the USSR has a number of missile producing plants already. Secondly, the USSR has a large stockpile of mothballed ICBMs which in the future will include SS-16s, SS-17s, SS-18s and SS-19s. Could these through a combination of pre-planned engineering of canister launchers and retrofitting of stockpiled ICBM bodies be made compatible with an MPS system?

The third approach to monitoring an MPS system is verification of aspects of its support and operations activities. For example, if the encapsulation of each missile in its canister launcher is done at a single facility, this plant could be monitored to see how many combined ICBM/launchers emerged. But, as is true for monitoring production, the requirements of high resolution and continuous observation rule out NTMs and dictate the need for on-site verification. The transport of the ICBM/launchers to the MPS site might also be monitored, especially if transport schedules and destinations were provided. If the MPS system is designed so that there is only one entry point to each set of protective structures or 'field' such a choke point could be monitored. In this regard, NTMs would appear inadequate, dictating the use of on-site black-box technology at the entry point and around the perimeter of the MPS field.

Problems with this general approach to verification include the possibility of undeclared ICBM/launcher assembly plants, the requirement that the opponent design his MPS system to facilitate verification and ensuring that the protective shelters do not have some rudimentary launch capability, independent of the canister-launcher.

The final verification approach is the most direct method. It involves sampling ICBM deployments in the MPS system by removing the blast covers on a fraction of the protective structures to allow photo-reconnaissance satellites to count the numbers of ICBMs. Opening the blast covers on all the protective shelters would be unacceptable since, for a critical period following such an inspection, the inspecting country would have target data which would permit it to destroy its missiles in a preemptive strike without diverting warheads onto the decoy shelters. Therefore a sampling approach is necessary. There is however a fundamental conflict in such a sampling approach: to be successful it should have a high probability of detecting significant cheating but at the same time the information gained should not permit the opponent to break the MPS system deception.

Meyer describes two sampling strategies: one involving a single pass by an observation satellite and the other involving a double pass. Using probability analysis, it is possible to calculate

H23(A79)

the minimum number of silos per squadron that would have to be inspected to achieve a specific probability of detecting a specific level of cheating.

A single pass inspection using large samples has technical and cost difficulties as well as the problem of reducing for a critical period the number of aim points at which an opponent must target his warheads. As Meyer points out in his Bulletin of the Atomic Scientists article, more verification is not necessarily better than less verification in a MPS environment. Efforts to achieve too high a level of verifiability will undermine the ability of the MPS to protect the land-based missiles.

More frequent but lower detection probability inspections could give a cumulative chance of detection equal to that for large samples. The party being inspected can also reduce the chance of disclosing MPS "cracking" information during the inspection by following certain procedures which Meyer describes.

In double pass inspections a preliminary examination is made of a small number of protective shelters in selected squadrons during the first pass. Based on the number of ICBMs observed, a second pass examines additional shelters in some of the same squadrons. Using this approach it is possible to reduce the total sample size. However, the techniques used for single pass inspection to reduce the possibility of disclosing information that would enable an adversary to crack the MPS system's deception, can not be applied for double pass verification.

For all these approaches to verifying an MPS system political questions arise over what constitutes adequate verification and over intrusiveness. In addition, any system involving a mobile launcher involves the possibility that a mobile missile could be configured which is independent of a particular type of launch canister.

Meyer concludes that in terms of intrusiveness and the amount of adversary cooperation involved, verification in an MPS environment is without precedent in strategic arms control. The least demanding approach in this respect is the sampling one; yet even in this case, NTMs are not useful unless active adversary cooperation can be guaranteed. In addition, there will be serious domestic political controversy over the verification system. Furthermore, the independent launcher concept inherent in an MPS system threatens to enhance break-out capabilities outside the MPS system. Finally, there is no reason to expect an opponent's system to be any more accomodating regarding verification than one's own.

In the Bulletin of the Atomic Scientists article, Meyer raises a few other points worth noting. He points to the difficulties raised by the possibility of false alarms due to technical limitations of NTMs. He also points to the necessity that a MPS system be linked to a verifiable ICBM limitations agreement if the system is to enhance the survivability of land-based ICBMs.

PROPOSAL ABSTRACT H24(A80)

1. Arms Control Problem:
   Nuclear weapons - mobile ballistic missiles

2. Verification Type:
   a) Remote sensors
   b) On-site insepction - selective

3. Source:
   Davis, Paul K.* "Land-Mobile ICBMs: Verification and Breakout". In Verification and SALT: The Challenge of Strategic Deception, pp. 143-162. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.

4. Summary:

This paper attempts to discuss arms control problems associated with land-mobile ICBMs and with shell-game deployment systems in particular. Three verification problems are identified:

1) Counting the number of ICBM launchers in overt ICBM deployment areas,
2) Verifying the absence of ICBM launchers in areas other than overt ICBM deployment areas, and
3) Coping with the possibility of "breakout".

Regarding the first problem, designs for shell-game systems are already constrained by SALT's provision preventing deliberate concealment measures which impede verification. However, there is no inherent contradiction between being able to count the other side's ICBM launchers and not being able to see them at all times, witness the counting of SLBM launchers. The proposed MX basing scheme will probably be verifiable for several reasons. First, the MX and its launcher will be built slowly and visibly near its deployment area. By constraints on production and access to the general areas, it will be possible to count the launchers with confidence using NTMs alone. In addition, it would be desirable to have provisions for sampling upon demand. The US could offer on-site inspection without requiring the Soviets to reciprocate providing that they satisfy US verification concerns if they deploy a similar shell-game system. Currently, however, the MX system is being designed for verification by NTMs.

Regarding the second verification problem, the author contends that it seems unlikely that the Soviets would try to cheat by deploying extra missiles in an overt deployment area. Instead, it is more appropriate to focus concern on small highly mobile missiles outside these areas.

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* Director of Special Regional Studies in the US Department of Defence Office of Program Analysis and Evaluation. The paper includes a note that the views expressed are not necessarily those of the US Department of Defence.

H24(A80)
H25(A74)

Regarding the possibilities of "breakout", Davis briefly outlines several scenarios. In the context of the shell-game MX system there is a possibility of "covert breakout" (i.e. acquiring enough reentry vehicles to neutralize the MX shell-game basing system) and "overt breakout" (i.e. the Soviets developing their own shell-game basing system which permits rapid expansion of their strategic force by filling up empty shelters if SALT II is abrogated). It is important that procedures for counting units prevent acquisition of reentry vehicles in excess of the numbers permitted and in excess of those counted in deciding how large the shell-game system should be. Shell game basing will create some unique breakout problems but their seriousness has been greatly exaggerated. Several hedges against both covert/overt breakout are discussed.

PROPOSAL ABSTRACT H25(A74)

1. Arms Control Problem:
   Nuclear weapons - reentry vehicles
   - missile tests

2. Verification Type:
   a) Remote sensors - satellite
   - shipboard
   - radar

   b) Complaints procedure - consultative commission

3. Source:
   Scoville, H. "A Leap Forward in Verification". In SALT: The Moscow Agreements and Beyond, pp. 160-182. Edited by M. Willrich and J.B. Rhinelander. New York: The Free Press, 1974.

4. Summary:

The author suggests that a limitation on the number of tests of MIRVed missiles could be verified with a high level of assurance using national technical means, primarily satellite and shipboard photography as well as various radar systems. An agreement to restrict tests to existing test ranges would make this task simpler but would not be essential. Such an agreement would be important in monitoring tests of MIRVed SLBMs.

The author suggests that attempts to conceal MIRV testing under the guise of a space program would be difficult to prove unequivocally, but that sufficient doubt would be raised to call for an inquiry through the Standing Consultative Commission established under SALT I. Similarily, MIRV tests designed to have only one re-entry vehicle enter the impact area would draw sufficient suspicion as a result of inconsistencies in mass characteristics to justify an inquiry.

PROPOSAL ABSTRACT H26(A78)

1. Arms Control Problem:
   Nuclear weapons - reentry vehicles
   - mobile ballistic missiles
   - cruise missiles

2. Verification Type:
   Remote sensors - aerial

3. Source:
   Perry, R. "Verifying SALT in the 1980s". In The Future of Arms Control: Part 1 - Beyond SALT II, Adelphi Papers #141, pp. 15-24. Edited by C. Bertram. London: International Institute of Strategic Studies, 1978.

4. Summary:

The author contends that aerial verification is particularly promising though it has received little attention since the early 1960s. In the modern world of MIRV, land mobile ICBMs, cruise missiles and other strategic gadgetry, the approach has a number of attractions:

1) It lacks some of the more intrusive aspects of on-site inspection since it can be conducted without exposing the military hardware of the host country to the close scrutiny of an inspector;
2) It promises a prompt and direct view of a suspect activity;
3) Concealment of any major weapons activity would be difficult because the reconnaissance aircraft need follow no set path or schedule and they are not necessarily inhibited from performing their assignment by night or bad weather; and
4) It is comparatively cheap, which creates the possibility that many nations could participate without having to rely on the good will of one of the superpowers.

As the author envisages it, the reconnaissance aircraft would be permitted to fly freely over the territory of the inspected nation. The aircraft would have to be incapable of performing offensive missions, of carrying strategic weapons or of detracting from the defensive potential of the nation being reconnoitered. This could be accomplished by ensuring that only "pure" reconnaissance aircraft could be used or by permitting on-the-ground inspection of each aircraft at any time.

PROPOSAL ABSTRACT H27(A78)

1. Arms Control Problem:
   Nuclear weapons - reentry vehicles
   - missile tests

2. Verification Type:
   a) Remote sensors
   b) International exchange of information

3. Source:
   Potter, William C. "Coping with MIRV in a MAD world". Journal of Conflict Resolution 22, no. 4 (December 1978): 599-626.

4. Summary:

The author argues that not all types of MIRVs are inherently destabilizing in terms of the strategic balance between the two superpowers. Specifically, MIRVed SLBMs may contribute to deterrence stability by increasing the number of warheads that would survive any first strike. On the other hand, several arguments can be made favouring a ban on MIRVed ICBMs.

Given this, Potter contends that the verification of a MIRV ban is not an insurmountable obstacle to agreement. It has been argued in the past that unless the MIRV program was halted before completion of its testing phase, there would be no feasible means of verifying a treaty concerning deployment limitations. The use of national technical means would not be sufficient to distinguish MIRVed and unMIRVed warheads according to this argument; it would be necessary to physically inspect the interior of a missile's reentry vehicle or examine it at close range with special instruments. Since neither of the superpowers is likely to agree to such on-site inspection both critics and supporters of MIRVs have tended to agree that a ban on MIRVs after they have been deployed is not likely.

The approach which US negotiators have adopted to circumvent the deployed MIRV verification problem is to assume that once any missile has been tested successfully in a MIRVed mode, all missiles of that type will be counted as MIRVed. There are several problems with this approach. First*, it does not permit one to distinguish between missile launchers which are identical except that one launcher contains MIRVs and the other does not. For example, how is one to determine the number of submarines carrying MIRVed missiles if the Soviets develop a new MIRVed SLBM which is compatible with old launchers on existing submarines? Requiring that all launchers capable of firing a MIRVed missile be counted toward the MIRV limit is not realistic, according to Potter.

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* Potter here cites Lodal, J. ('Verifying SALT'. Foreign Policy 24 (Fall, 1976): 40-64) as the originator of these criticisms.

Another problem with the above "typing" approach is that its political feasibility derives in part from the high MIRV ceiling tolerated. Because there is only limited advantage to be gained from cheating when MIRV levels are set so high, compliance with the limitation is encouraged.

Potter contends that a verifiable way to limit deployed MIRVs is a "confidence flight test quota". This approach relies for its effect upon the loss of confidence in the operational reliability of MIRVed missiles that would result from an agreement to halt or at least substantially reduce the number of annual flight tests of strategic missiles in a MIRVed mode. While this approach can be applied to all MIRVed missiles, Potter favours focussing the limitations upon MIRVed (and preferably MRVed) land-based ICBMs.

One of the main advantages of such a flight test quota is that it is not dependent upon a high MIRV ceiling (as the "typing" rule approach entails). In addition, it requires no technological improvements in reconnaissance capabilities. Greenwood's* assessments of US reconnaissance capabilities are cited by Potter in support of his position. The task of verification could be reduced further if the flight test agreement also provided the tests of long-range missiles be pre-announced and conducted at specified test ranges.

One verification problem with such a flight test limitation concerns distinguishing MRV tests from MIRV tests. The obvious and desirable way to alleviate this difficulty is to include MRVs within the scope of the flight test ban. If this is not politically feasible, verification problems could be reduced by requiring that flight tests be preannounced and confined to agreed test paths thereby increasing the probability that the release stage of the reentry vehicles (when MRVs and MIRVs are most distinguishable) could be photographed.

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* See abstract H32(A72).

PROPOSAL ABSTRACT H28(A77)

1. Arms Control Problem:
   Nuclear weapons - cruise missiles

2. Verification Type:
   Remote sensors - satellite

3. Source:
   Tsipis, K. "Cruise Missiles". Scientific American 236, no. 2 (February 1977): 20-29.

4. Summary:

The author analyses several arguments concerning the value of different types of cruise missiles. He notes that national technical means of verification could distinguish between tactical and strategic cruise missiles on three counts:

a) Tactical cruise missiles have a volume of less than half a cubic metre, while strategic cruise missiles have volumes greater than half a cubic metre.
b) tactical cruise missiles are powered by turbojet engines while strategic models are powered by turbofan engines.
c) Tactical cruise missiles have a thrust of less than 600 pounds, while strategic models have a thrust of over 600 pounds.

From these criteria it is possible to differentiate between strategic and tactical cruise missiles on the basis of the characteristic thrust signature left by all missiles. This can be accomplished by reconnaissance satellites using infra-red devices.

PROPOSAL ABSTRACT H29(A61)

1. Arms Control Problem:
   Nuclear weapons - missile tests

2. Verification Type:
   Remote sensors - radar
   - aerial
   - satellite

3. Source:
   Wiesner, J.B. "Inspection for Disarmament". In *Arms Control: Issues for the Public*, p.p. 131-132. Edited by L. Henkin. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

4. Summary:

This proposal calls for the use of remote sensing to monitor a missile test ban. The suggested sensors would include the following:

a) ground-based conventional radar,
b) ground-based high frequency radar,
c) airborne infra-red detection,
d) acoustic detection,
e) detection of fuel products,
f) radio beacons or transponders on authorized vehicles, and
g) satellite-based infra-red detection.

H30(A62)

PROPOSAL ABSTRACT H30(A62)

1. Arms Control Problem:
   Nuclear weapons - missile tests

2. Verification Type:
   a) Remote sensors - radar
   b) On-site inspection - selective

3. Source:
   Fletcher, J. "Some Problems Involved in a Missile Test Ban". In Woods Hole Summer Study, Verification and Response in Disarmament Agreements, Annex, Volume I, Appendix G, pp. 75-78. Washington, D.C.: Institute for Defense Analysis, November 1962.

4. Summary:

This proposal deals with a possible agreement that would;

a) prohibit missile test flights with a range greater than two hundred nautical miles;
b) require prior notice of four weeks for flight tests of space vehicles and confirmation on the day before the flight; and
c) require that states conducting space launchings permit other states to attend the launchings.

The right to inspect payloads and boosters would not be granted.

The verification procedures suggested include the establishment of radar monitoring stations on the territory of all states engaged in flight tests of missiles or space vehicles. It is suggested that somewhere between 15 and 150 stations would be required depending on the coverage desired.

Alternatively, it is suggested that all missile launch facilities could be monitored by inspectors permanently stationed at these facilities.

PROPOSAL ABSTRACT H31(A62)

1. Arms Control Problem:
   Nuclear weapons - missile tests

2. Verification Type:
   a) Remote sensors - radar
   b) On-site inspection - selective

3. Source:
   Woods Hole Summer Study. Verification and Response in Disarmament Agreements, Annex, Vol. I. Washington, D.C.: Institute for Defence Analysis, November 1962.

4. Summary:

This proposal suggests that a missile test ban would act as a brake on R&D programs insofar as such a ban would place severe limits on the confidence a military establishment could have in new missile systems.

It is proposed that existing radar facilities could be used to verify compliance with a ban and that only a small number of detection stations would need to be established on the territory of states party to the agreement in order to verify that short-range tests (200 miles or less) are not being conducted. Observation of missile test sites could also be carried out by a small number of on-site inspectors. Finally, covert intelligence would be used to uncover plans for clandestine tests.

The authors note that while this system would be unable to provide reliable information about penetration aids and guidance systems, it could provide accurate data about the overall behaviour of missile systems.

H32(A72)

PROPOSAL ABSTRACT H32(A72)

1. Arms Control Problems:
   Nuclear weapons - missile tests
   - re-entry vehicles

2. Verification Type:
   Remote sensors - radar
   - satellite
   - shipboard

3. Source:
   Greenwood, T. Reconnaissance, Surveillance and Arms Control, Adelphi Papers #88, London: International Institute of Strategic Studies, 1972, pp. 15-22.

4. Summary:

Greenwood commences this section of his paper with a discussion of methods presently used by the United States of America to monitor Soviet and Chinese missile tests. These include:

1. Line-of-sight radar: These comprise installations in Turkey and the Pacific area as well as the BMEWS radars in Greenland and Alaska. They provide the information on the following:
   a) the existence of a test, unless it is arranged so as not to come within range of any of the radars or unless there is a mechanical failure,
   b) the missile's trajectory and hence range and impact area, and
   c) some characteristics of the missile and re-entry vehicle, like size and shape.

   On the basis of these data, second order information can be deduced. "For example, the type of missile or re-entry vehicle may be determinable from the radar echo and thus it might be possible to judge when a new missile system is being tested. From the frequency of the tests, the progression of such a new system through its development, test and deployment cycle might be monitored." (p. 16)
2) Over-the-horizon (OTH) radar: By reflecting off the ionosphere OTH radar can achieve long ranges. There are two types: back-scatter OTH which can determine the velocity and acceleration

of a missile, and forward scatter OTH which can identify a missile by its exhaust signature.

3) Satellite systems: As is the case for OTH radars, satellite systems which can detect and track missiles were developed primarily to provide early warning of a missile attack. The main sensors employed for this task are infra-red telescopes and television. Newer satellites have the capability of real time monitoring of tests.
4) Shipboard sensors: These provide detailed information about the re-entry vehicles, its manoeuvrability and the missile's accuracy.

Greenwood continues by assessing the utility of these systems for verifying restrictions on qualitative improvements in ballistic missiles. He suggests, first, that to discourage development of new missile systems incorporating improvements in accuracy or re-entry vehicle design, an overall limit could be imposed on the number of tests in a given period of time. The rationale for this is that if the upper limit on the number of tests were small enough, new systems could not be developed. Verifying of such a ban would be easier if the agreement included "a prescription that all long-range missiles be tested along designated flight paths and or only at pre-announced times" (p. 20). However, such a prescription is not absolutely necessary for a limitation on the absolute numbers of tests. It would be a more important element for the less restrictive limitations on qualitative improvements discussed below. Existing American technical capabilities such as line-of-sight radar, OTH radar and early warning satellites "would permit, with a high degree of confidence verification of an agreement limiting the number of missile tests". (p. 20). But could the Union of Soviet Socialist Republics circumvent the aim behind a numerical limitation on tests by foregoing maintenance testing of existing missiles and concentrating only on testing of new technology? To answer this Greenwood examines American capabilities to monitor qualitative improvements during missile tests. He concludes that "with current capabilities, hardware different from that which had already been tested could probably be recognized as such" (p. 21). The indroduction of new boosters could be verified with high confidence as could any appreciable change in the structure, size or weight of the re-entry vehicle.

H32(A72)

Less restrictive limitations than the above might also be considered. A ban on terminal manoeuvring and terminal guidance of re-entry vehicles could probably be verified by existing technology. Restrictions on improvements in accuracy would be more difficult to verify since information on this characteristic must derive from second order inference. "Such a restriction could, however, be imposed indirectly by prohibiting terminal manoeuvring and by imposing limits on the ballistic coefficient of re-entry vehicles" (p. 22), both of which could be verified adequately. Even better would be a total prohibition on new re-entry vehicles.

A complete ban on multiple warhead tests could be verified by shipboard and perhaps other sensors, as well as the new early warning satellite system, when it is operational. However, it is not possible to effectively distinguish the development of a MRV capability from the development of a MIRV capability, and consequently, any limitation based on this distinction cannot be verified.

PROPOSAL ABSTRACT H33(T72)

1. Arms Control Problem:
   Nuclear Weapons - anti-ballistic missile systems
   - ballistic missiles
   - manned bombers

2. Verification Type:
   a) Remote sensors
   b) Complaints procedure - consultative commission

3. Source:
   SALT I Agreements:
   1. Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems. (The ABM Treaty).
   2. Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitations of Strategic Offensive Arms.

   Both signed: 26 May 1972.
   Both entered into force: 3 October 1972.*
   See also: United States. State Department. Bureau of Public Affairs. Compliance with SALT I Agreements, Special Report no. 55. Washington, D.C.: July 1979.

4. Summary:

The ABM Treaty and later protocol restricts deployment of ABM systems to two areas - one for defence of the national capital area and the other for defence of an ICBM site. Limits are placed on the number of missiles and radar systems and on ABM research. Finally, testing of ABM systems is restricted to current or "additionally agreed" sites under the agreed interpretation of Article 4 included in the Protocol of the Treaty.

Verification is to be accomplished by "national technical means" used "in a manner consistent with generally recognized principles of international law" (Article 12). Each party is obligated not to interfere with the other party's means of verification and not to use deliberate concealment measures. Complaints are to be referred to a Standing Consultative Commission (Article 13).

* The agreements expired in October 1977. However, both parties have agreed to behave as if they remained in force.

The Interim Agreement provides for limits and restrictions on numbers and types of strategic nuclear weapons delivery vehicles. As under the ABM Treaty, verification is to be conducted by national technical means (Article 5, which is identical to Article 12 of the ABM Treaty). Complaints are to be referred to a Standing Consultative Commission (Article 6).

The Standing Consultative Commission was created by a Memorandum signed and entered into force on 31 December 1972. According to this agreement either party can request a meeting of the Commission at any time, though two meetings at least must be held each year. The scope of the Commission's functions were originally defined for the ABM Treaty (Article 12), but were later extended by the Memorandum of December 1972, to include other arms control agreements between the two super-powers.

The Parties can within the framework of the Commission:

1. consider questions concerning compliance with the obligations under the various treaties with which the Commission is concerned;
2. provide on a voluntary basis such information as either party considers necessary to assure confidence in compliance;
3. consider questions of unintended interference with national technical means of verification;
4. consider possible changes in the strategic situation which have a bearing on the treaties; and
5. consider proposals on increasing the viability of the treaties and on further limiting of strategic arms.

On May 30, 1973 the Commission agreed on the regulations to govern its meetings. The following are the main points of these regulations:

1. The chairmanship, of the meetings alternates between the parties.
2. Advance notice of any topic of discussion is to be given when possible.
3. Any expert adviser deemed necessary may participate in a meeting.
4. The commission may establish working groups to deal with specific matters.
5. The proceedings are to be conducted in private and neither party can make them public without the express consent of the other.
6. Each party bears the expenses connected with its participation.

1. Selected Comments of States:

The United States Department of State's report entitled Compliance with SALT I Agreements briefly describes the United States government organizational framework for verifying SALT I. It then lists the questions concerning compliance which both sides have raised in the Standing Consultative Commission to July 1979. It also responds to press reports alleging Soviet violations of SALT I, denying that they occurred. A careful reading of this document gives useful insight concerning the attitudes of both sides to compliance with the agreement and provides an indication of the verification capabilities of both sides.

H34(A78)

PROPOSAL ABSTRACT H34(A78)

1. Arms Control Problem:
   a) Nuclear weapons - anti-ballistic missile systems
   - ballistic missiles
   - reentry vehicles
   b) Conventional weapons - ground forces

2. Verification Type:
   a) Remote sensors - satellites

3. Source:
   Stockholm International Peace Research Institute. Outer Space-Battlefield of the Future. London: Taylor and Francis, 1978, pp. 184-185.

4. Summary:

Since ground resolutions of .15 metres for photoreconnaissance satellites are feasible there should be no difficulty in observing and identifying such objects as ABMs and ICBMs. It would be equally easy to use satellites to guard against significant concentrations of armed forces.

However, such control methods cannot be used to check qualitative changes in military systems although the development of certain new weapons can be detected at the testing stage. Even for quantitative verification, satellites are limited by the fact that for certain weapons, such as MIRVs, the identifying components are enclosed within the missile and hence undetectable.

For any verification by satellite an obligation not to use concealment for impeding verification is essential. This is incorporated into SALT I and should be applied to all other arms control treaties. The development of new sensors to penetrate some camouflage does not make this obligation of non-concealment any less important. Equally, a prohibition on interference with satellites is needed. The concept of verification by satellites could be jeopardized by developments such as satellite intercept and destroy systems.

PROPOSAL ABSTRACT H35(A80)

1. Arms Control Problem:
   Nuclear weapons - missile tests

2. Verification Type:
   Remote sensors - aerial
   - ELINT
   - ground based
   - satellite
   - shipboard

3. Source:
   Scoville, Herbert Jr. "Verification of Soviet Strategic Missile Tests". In Verification and SALT: The Challenge of Strategic Deception, pp. 163-176. Edited by William C. Potter. Boulder, Colorado: Westview Press, 1980.
   See also: "SALT Verification and Iran". Arms Control Today 9, no. 2 (February 1979).

4. Summary:

Scoville contends that during the test phase it is possible to obtain much detailed data on the nature of a new weapons system which might be concealed once it is deployed. There is, furthermore, a correlation between deployment and testing because strategic systems require extensive tests in a near operational configuration and conditions to acquire a reliable capability. The author reviews Soviet missile test sites and American resources for monitoring these sites.

Observations of Soviet missile tests are essential to verifying SALT II. The ABM, SALT I and SALT II treaties all have provisions designed to assist verification. A summary of the more important provisions of this nature in SALT II is provided.

Scoville next assesses the US capability to monitor various provisions in the ABM and SALT II treaties. He concludes that with a combination of available systems, the US can be confident that no undetected Soviet violation could significantly affect American security, in spite of the loss of intelligence collection sites in Iran.

H36(G72)
H37(G76)

ABSTRACT PROPOSAL H36(G72)

1. Arms Control Problem:
   Chemical weapons - research and development

2. Verification Type:
   Remote sensors - satellite

3. Source:
   United Kingdom. "Working paper on remote detection of chemical weapons field tests". CCD/371, 27 June 1972.

4. Summary:

It is assumed in this paper that field testing would be an essential part of any development of a CW. However, this applies only with respect to new weapons. Consequently, the verification technique proposed here will not be useful for detecting CWs already in existing stocks. The paper describes the sensitivity and performance requirements of satellite sensors and gives probability estimates for detecting a CW field test.

The paper comes to the conclusion that limited detection by satellite sensors of chemical field tests of known agents is technically possible. The most promising system is an infra-red sensor (photoconductive detector) mounted on a geostationary satellite. The incidence of cloud cover, however, is the major and a serious limiting factor.

PROPOSAL ABSTRACT H37(G76)

1. Arms Control Problem:
   Chemical weapons - research and development

2. Verification Type:
   Remote sensors - sampling

3. Source:
   United Kingdom. "Working paper on the feasibility of extraterritorial surveillance of chemical weapon tests by air monitoring at the border". CCD/502/Corr. 1, 2 July 1976.

4. Summary:

Two possible methods of remote verification of CW field

tests involve the use of:

1) satellites (discussed in CCD/371*), and
2) ground stations situated outside national boundaries and equipped to detect CW agents in air masses which passed over areas where the weapons were thought to be tested.

Once a reliable indication of a violation had been obtained by the above techniques, on-site inspection would be called for. This paper assesses the second method's feasibility.

A number of analytical methods of monitoring air are presented (Appendix A of the working paper). It is concluded that the most sensitive method of instanteous monitoring with a capability for identification is the Fourier infra-red technique similar to that which might be used on a satellite. The most sensitive system for sample accumulation with subsequent analysis would combine a highly efficient sampler with gas chromatographic analysis using a specific phosphorus detector.

An assessment of these techniques' chances of success is made using calculations based on general meterological knowledge and conditions around three sites in particular. It is concluded that:

a) Detection of a field test by instantaneous monitoring of air at a national boundary is not feasible at a distance of 10,000 km from the source and could probably not be achieved beyond a distance of 500 km.
b) A sample accumulation system might theoretically detect an organophosphorous compound in a puff released 10,000 km upwind. But this conclusion still requires further study.
c) Identification of organophosphorus agents by the system described is not possible and in view of the risk of false alarm resulting from the detection of commercial compounds, this system is not worthy of further consideration until the identification threshold is improved.

* See abstract H36(G72).

H38(G77)

PROPOSAL ABSTRACT H38(G77)

1. Arms Control Problem:
   Chemical weapons - research and development
   - production
   - stockpiling
   - destruction of stocks

2. Verification Type:
   a) Remote sensors - satellite
   b) Records monitoring - economic
   c) Literature survey

3. Source:
   Union of Soviet Socialist Republics. "Some methods of monitoring compliance with an agreement on the prohibition of chemical weapons". CCD/538, 3 August 1977.

4. Summary:

The working paper states that there are two methods of verifying a CW ban: intraterritorial and extraterritorial monitoring. Intraterritorial monitoring can be further subdivided into international and national monitoring. All technical means of verification including laboratory, remote, indirect (i.e. analysis of statistics), and conservative methods (i.e. sealing installations, telemetric and radiometric surveillance) are fully applicable to intraterritorial national monitoring. However, the use of these means in international monitoring is "inevitably associated with the disclosure of military, industrial and commercial secrets and consequently cannot be justified from the standpoint of assuring the security and economic interests of the States parties to a future agreement. The present paper therefore takes as its starting point the need to assess the applicability of the above methods to extraterritorial monitoring."

Development (including testing) of CWs:

Indirect extraterritorial monitoring in this regard might involve searching for the presence of:

1) research centres,
2) testing centres in active operation, and
3) specific systems of scientific and technical planning and financing.

Additionally, monitoring published patents and scientific publications which indirectly reflect the

interests of specialized chemists, could be useful. Undeclared tests might also be detected using remote instrumentation techniques.

Production of CWs:

This could be monitored by recording and analysing the various emissions from chemical plants into the air and water using remote techniques. Indirect methods, particularly statistical analysis based on estimates of consumption of initial and intermediate substances used in the production of CWs, is an especially promising approach.

Stockpiling of agents and munitions:

This is virtually impossible to detect directly by extraterritorial means. Detection by remote methods of transport operations, however, is possible. Indirect methods expecially statistical analysis of inter-state monetary and financial transactions (i.e. to detect transfer of CWs between states) may be of some importance.

Destruction of Stocks:

This can be monitored by a remote method - recording with sensitive instruments of specific gaseous substances which may be discharged into the atmosphere as a result of the destruction process. Indirect monitoring is feasible only where destruction entails making material preparations. Also destruction may entail substantial expenditure and may thus be reflected in the budgets.

The above analysis leads to the following conclusions:

1) The most effective monitoring system involves the use of "national means...for the purpose of intraterritorial national and extraterritorial monitoring".
2) "laboratory, remote, indirect and conservative methods can be used in intraterritorial national monitoring in all cases".
3) "extraterritorial monitoring can be performed chiefly by remote and indirect methods".

Remote methods:

The working paper continues with a more detailed examination of remote monitoring. This method, the paper claims, can be employed in two situations:

1) Where a sample for monitoring is delivered naturally in a current of air or water and samples are taken for laboratory analysis. This method depends to a great degree on natural conditions and phenomena.
2) "Where analysis is based on remote appraisal of some optical (spectral) characteristics of the monitored sample" through the use of artificial satellites. This method, the paper claims, is the more reliable.

A previous UK working paper on satellite detection of CW field tests* is mentioned. The Soviets suggest that a better instrument than that suggested in the UK paper would be "a monolithic detector based on impure crystals at ultra low temperatures (a condition easily attainable in outer space)". Other ways to achieve high detection sensitivity include the use of "the induced and resonance combination scattering (Shorygin) effect" employing modulated lasers.

* CCD/371, abstract H36(G72).

The paper continues with its technical discussion of detection devices. It suggests that the best employment of detectors would involve "the use of a combined system in which one satellite is positioned in geostationary orbit while others revolve in low circular orbits at an altitude of about 250 km."

The working paper claims that through improved instrumentation it will be possible "to record with a high degree of reliability the presence in the atmosphere of very low concentrations of chemical agents and consequently to detect the production of chemical weapons and field tests of such weapons".

Indirect methods:

These are effective for extraterritorial monitoring when based on analytical processing of a wide range of information accessible to the general public concerning the development, production and stockpiling of chemical agents. "In addition use may be made of the national information centres already in existence which analyse for commercial purposes the activities of various foreign research centres, factories, firms..." and individual scientists. Since such national systems for selecting and evaluating information in all fields of science and technology exist in the majority of developed states, it is almost impossible that any of these states could outstrip the others for a long period and on a large scale, in any branch of fundamental military technology including chemical weapons without being detected.

> Thus the sum total of remote and indirect methods of monitoring afford adequate scope for extraterritorial monitoring by national means. By combining those methods with the specific methods of intraterritorial national monitoring...a comprehensive and effective solution can be found for the entire problem of monitoring compliance with an agreement on the prohibition of chemical weapons.

PROPOSAL ABSTRACT H39(A80)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities

2. Verification Type:
   a) Remote sensors
   b) On-site inspection - selective

3. Source:
   Mikulak, R.* "Destruction of US chemical weapons production and filling facilities". In Stockholm International Peace Research Institute, Chemical Weapons: Destruction and Conversion, pp. 57-66. London: Taylor and Francis, 1980.

4. Summary:

After facilities have been declared to be CW production plants, the first step is to verify that this is true. The simplest and most reliable way to do this is through on-site inspection by technical experts.

In the initial phases of actual destruction of the plant the following might be observed:

a) delivery and storage of large quantities of decontaminant chemicals,
b) disposal in open ponds of liquid wastes,
c) installation and operation of equipment for spray-drying of liquid wastes,
d) installation and operation of a metal parts furnace, and
e) accumulation of piles of scrap metal.

If much of the process equipment were located in the open, destruction could be observed directly. However for facilities where equipment is housed indoors most of the destruction could only be monitored indirectly. If scrap piles were observed remotely, they could be compared with the equipment noted on previous on-site visits. But even for indoor equipment, some dismantling might be observable directly such as removal of external storage tanks. Demolition of buildings could be easily monitored from a distance and would provide the simplest and most conclusive evidence that the facility had been destroyed. Remote monitoring might be facilitated by prior agreement on the procedures to be employed in destruction and dismantling.

* Employee of US Arms Control and Disarmament Agency.

H40(A74)

PROPOSAL ABSTRACT H40(A74)

1. Arms Control Problem:
   a) Conventional weapons - ground forces
   b) Regional arms control - Europe

2. Verification Type:
   a) Remote sensors - aerial
      - satellites
   b) On-site inspection - control ports
   c) International exchange of information

3. Source:
   Coffey, J.I. New Approaches to Arms Reduction in Europe, Adelphi Papers #105. London: International Institute of Strategic Studies, 1974.

4. Summary:

Three alternative proposals are actually contained in this paper to verify either the existence of forces, their reduction or their withdrawal.

First, if country X questions whether country Y has really withdrawn all its tanks, from a prescribed border zone for example, Y could send X aerial photos of the zone, the validity and timing of which could be easily verified by national means. If the photos showed no tanks, X would know there had been no tanks there at all or that the tanks had been removed before the photos were taken.

Second, Y could announce the location of the units suspected of being in the zone, inviting observation by X (or Z) to verify that the units were in fact elsewhere. This would avoid extensive extra-national inspection systems. Supplementary to these two proposals, the author suggests that an agreement could be reached not to interfere with aircraft equipped with side-looking radar flying along but not across national boundaries.

Third, parties to an agreement could permit overflights of given areas (such as border zones) or a small number of "on call" flights through these zones, along main lines of communication or over prescribed areas which might serve as jump-off points for attacks, or sites for the build-up of supplies and equipment.

These measures would complement other national means of verification such as observation posts and satellites. Together they could provide a maximum of reassurance against gross violations of restrictions on deployment, without involving the acquisition of the sort of detailed information about weapons systems and military installations which might derive from general on-site inspection.

PROPOSAL ABSTRACT H41(A74)

1. Arms Control Problem:
   Conventional weapons - ground forces

2. Verification Type:
   Remote sensors - satellite

3. Source:
   Scoville, H. "A Leap Forward in Verification". In SALT: The Moscow Agreements and Beyond, pp. 160-182. Edited by M. Willrich and J.B. Rhinelander. New York: The Free Press, 1974.

4. Summary:
   This proposal suggests that significant troop movements can be monitored, at least in daylight, by visible light photography by satellites. Military equipment could also be monitored by satellite sensors, even if camouflaged. The author proposes that any agreement seeking to restrict troop deployments (in Europe for instance) should include a clause similar to Article XII of the ABM Treaty making it a violation to deliberately conceal redeployments of troops and military vehicles. If it were further stipulated that troops and military vehicles could only cross borders at specific points, and only during the daytime, the work of verification would be greatly simplified. Such provisions would also assist in the task of differentiating between normal resupply operations and the reintroduction or redeployment of forbidden forces.

H42(A75)

PROPOSAL ABSTRACT H42(A75)

1. Arms Control Problem:
   a) Regional arms control - demilitarization
      - Mediterranean Sea
      - Indian Ocean
   b) Conventional weapons - ships

2. Verification Type:
   a) Remote sensors - satellite
      - aerial
   b) Complaints procedure - oonsultative commission

3. Source:
   Blechman, B.M. The Control of Naval Armaments: Prospects and Possibilities. Washington, D.C.: The Brookings Institute, 1975. Especially pp. 42-46 and Appendix B.

4. Summary:

The author proposes a format for agreements between the two superpowers on regional naval disengagement. His focus is mainly on two geographic areas: the Mediterranean Sea and the Indian Ocean. The proposed agreement would provide for removal of naval forces and perhaps shore installations from the area in question, as well as restrictions on future naval deployment there. As envisaged, each party would rely primarily on "unilateral means of verification" by which is meant satellite and aerial reconnaissance. In respect to an agreement on disengagement in the Mediterranean, Blechman foresees little difficulty concerning such monitoring techniques. The Mediterranean is surrounded by land areas with only a few narrow entrance and exit points at which movements of naval vessels including submarines could easily be monitored.

The problem is somewhat more difficult in regard to disengagement in the Indian Ocean, which unlike the Mediterranean is an open body of water. Nevertheless, Blechman believes that satellite reconnaissance would be sufficient to detect any violation by surface ships in the area. Submarines pose a more serious problem since they can not be detected from satellites. "It might be possible to monitor a submarine restriction by tracking all submarines from the time they left their home ports, but neither signatory would have much confidence in such an approach." (p. 70) To counterbalance this problem over verification the author points out the serious political consequences that would be

entailed by any breach. Furthermore, the author can not imagine how any Soviet infringement "even if large numbers of submarines were involved (which, of course, increases the likelihood of discovery), could seriously jeopardize the security interests of the United States". These considerations suggest that the verification problem with respect to submarines should be overlooked.

In addition to national means of verification, Blechman proposes the establishment of a "joint control commission", to oversee implementation of the agreement. The membership of the Commission would consist of one representative from each superpower and one delegate nominated by the littoral states of the region in question. The commission's functions would be:

> ...to report on activities and to serve as a forum for continual consultation and negotiation. Nations deploying forces in the region would inform the commission in advance, which would then monitor and report their compliance with or deviation from prescribed limitations. Involving local states in verification of the agreement is an additional insurance against cheating or other forms of noncooperation. Under a commission so constituted, a violation would be not only against the other signatory but against the states of the region. (p. 46).

PROPOSAL ABSTRACT H43(A76)

1. Arms Control Problem:
   Regional arms control - Europe

2. Verification Type:
   a) Remote sensors
   b) On-site inspection - control posts

3. Source:
   Lodal, Jan M. "Verifying SALT". Foreign Affairs 24 (Fall 1976): 62-64.

4. Summary:
   Little attention has been paid to verification problems in the context of mutual and balanced force reductions in Europe according to Lodal. Relatively modest troop reductions (20,000 to 50,000 troops) such as those most commonly discussed for an MBFR first step, cannot be verified with high confidence by national technical means. Distinguishing troop withdrawals from rotation of troops would be difficult without a massive inspection force stationed at every railyard, road junction and airport in Eastern Europe. In the case of MBFR a potential agreement is more a political symbol and would not appreciably alter the military balance making air-tight verification of little relevance.

H44(A78)

PROPOSAL ABSTRACT H44(A78)

1. Arms Control Problem:
   Regional arms control - outer space

2. Verification Type:
   1) Remote sensors
   2) International exchange of information - reports to international body
   3) Complaints procedure - consultative commission.

3. Source:
   Scoville, Herbert, Jr., and Kosta Tsipis. Can Space Remain A Peaceful Environment? Muscatine, Iowa: The Stanley Foundation, July 1978. Occasional Paper, no. 18.

4. Summary:

   The authors review the current and future US and Soviet capabilities in space and the potential for space warfare. They call for an agreement aimed at prohibiting further testing, deployment or use of any Earth-based or space-based systems designed to damage, destroy or interfere with the functioning of any spacecraft of another nation. Such a prohibition, however, could encourage the use of space for deploying dangerous military systems, by guaranteeing their invulnerability. Therefore such an agreement should also include a ban on the stationing in orbit, on celestial bodies or elsewhere in outer space of weapons designed to inflict injury or damage on Earth, in the atmosphere or on objects launched into space.

   Verification problems will primarily arise from the difficulty of differentiating between legitimate and proscribed space activities. It is therefore important to include in the treaty supplemental mechanisms for facilitating verification. The authors recommend mandatory reports to the UN by states launching spacecraft. This would ensure greater timeliness and more detailed information in contrast to the current voluntary reporting system. Information reported would include the mass and orbits of the objects, changes in orbital characteristics and notification of anticipated reentry. Current and improved national technical means could be used to check the accuracy of the reports.

   Ambiguities would still arise, therefore the UN should also establish a multinational body, similar to the bilateral US/USSR Standing Consultative Commission, to consider questions of compliance. This body would not have the power to rule that a violation had occurred but only to bring to the attention of all parties the pertinent facts.

PROPOSAL ABSTRACT H45(G57)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) Remote sensors - aerial
   b) On-site inspection - control posts

3. Source:
   United States. White House Disarmament Staff. Fact Sheet on Aerial Inspection. Washington, D.C.: September 1957. Disarmament Background Series, no. M-9. Cited in Inspection for Disarmament, pp.69-71. Edited by Seymour Melman. New York: Columbia University Press, 1958.

4. Summary:
   The authors suggest the following:
   1) Specially designed peripherial air bases just within the boundaries of participating nations could be used as clearance points for inspection flights. Air inspection command posts might be permanently stationed at such bases.
   2) Preparatory to every aerial inspection mission, aircraft could be closely examined by representatives of the host country either visually and/or by radiation detection devices.
   3) A representative of either the host country or the international control organization would be assigned to each inspection mission to ensure compliance with all regulations. He might be allowed to maintain radio communication with the monitoring agency of the inspected country.
   4) Air inspection teams, while being unrestricted as to where they might fly (provided this area fell within the terms of the arms control agreement), would be required to file a detailed flight plan in advance of the inspection mission and would be obliged to adhere strictly to the plan.
   5) All inspection aircraft would be unarmed and crews would be required to adhere closely to regulations governing air traffic safety in the host country.
   6) Throughout their inspection flight, aircraft would be kept under constant surveillance, either electronically or visually by an armed host country companion plane.
   7) The same provisions as in #4 and #6 could be used to control the approach of inspection planes to national frontiers. These could be required to follow designated air corridors.

H45(G57)
H46(A68)

8) Following inspection flights, the host country would have no access to reconnaissance material gathered during the mission. Unless the agreement provided for international control of the information, it would remain the sole property of the nation which had conducted the inspection mission.

PROPOSAL ABSTRACT H46(A68)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) Remote sensors - aerial
   b) On-site inspection - progressive/zonal

3. Source:
   Frye, W.R. "The Disarmament Turning Point". Bulletin of the Atomic Scientists 12, no. 5 (May 1968): 166-168.

4. Summary:
   This proposal envisages initial projects of aerial and ground inspection to act as confidence building measures in a process of progressive verification. Initially, relatively small areas (perhaps 20,000 - 30,000 square miles) could be made subject to aerial surveillance, with ground personnel inspecting at least one communications centre and one airfield in each area. Aerial and ground inspectors would report directly to a central control headquarters.

   If all goes well, the area open to inspection could be gradually enlarged, until all territory was opened to general inspection.

PROPOSAL ABSTRACT H47(G76)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) Remote sensors
   b) On-site inspection - selective
   c) International exchange of information
   d) International control organization

3. Source:
   United States. Arms Control and Disarmament Agency. Verification: The Critical Element. Washington, D.C.: March 1976, Publication 85.

4. Summary:

Verification according to this publication is the process of assessing compliance with the provisions contained in arms control agreements. Its purposes are to detect violations giving timely warning to innocent parties, to deter violations and to build domestic and international confidence in the viability of arms control. Among the aspects of the verification issue discussed in this paper are the relationship of verification to intelligence gathering, factors in assessing the adequacy of a verification system and past verification proposals.

The methods of verification used depend on the character of the restrictions to be monitored, the security importance of possible violations and judgements of political benefits. National technical means which remain outside the territory of the party being monitored have several advantages. In addition to flexibility these include avoiding the need for foreign inspectors on one's territory and the need for ensuring the independence and effectiveness of inspectors. But NTMs also have their limits.

On-site inspection and monitoring can take a variety of forms including mobile teams, fixed posts, and tamper-resistant unmanned monitoring instruments. It is important to distinguish the symbolic or political value of inspection from its actual verification value. Inspections can be frustrated; one of the goals of inspection is to give evidence of such obstruction.

Exchanges of information can provide useful data to check that obtained from other sources. In addition, it involves cooperation which can serve as a precedent. But it cannot be relied on alone.

For multilateral agreements international organizations can play a verification role. But "while it is true that charges of violations by an international body are likely to carry greater weight in the world community than allegations made by adversaries, it is also true that an international body may encounter internal politically motivated opposition to seeking out evidence of violations or to reaching a formal verdict concerning evidence that may actually be discovered"(p.20). It is also probable that such

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bodies will have limited staffs and funds as well as antiquated verification technology.

The ACDA paper acknowledges that few arms control agreements are verifiable with total certainty. "Given the determination to violate an agreement and to brave the consequences of possible detection and given sufficient expenditure of resources and time and sufficient ingenuity, the most determined verification effort could probably be frustrated and evaded to some extent" (p. 21). Both the technical capabilities of monitoring methods and military and political judgements affect assessment of the verifiability of an agreement.

Three types of violations are mentioned in the paper:

1) Local. These occur without the support of the central government.
2) Deliberate but limited. These arise from misunderstandings or deliberate attempts to stretch an agreement.
3) Deliberate and massive. These are attempts to achieve military or political advantage.

The third type could be mistaken for one of the less serious forms. The first two types may be less serious but should not be ignored since they could evolve into the third form.

Once a violation is detected it is necessary to respond. Factors affecting response include the quality of the evidence, the source of the evidence, the facts of the case and the objectives of national policy. Modes of response can range through requests for clarification, diplomatic protests, public requests for the activities to cease, notification that compensatory action will be taken, and denunciation and withdrawal from the agreement.

PROPOSAL ABSTRACT H48(A77)

1. Arms Control Problem:
   Any arms control problem

2. Verification Type:
   a) Remote sensors - satellite
   b) International exchange of information

3. Source:
   Chayes, A., W. Epstein, and R.B. Taylor. "A Surveillance Satellite for All". Bulletin of the Atomic Scientists 33, no. 1 (January 1977): 7.

4. Summary:
   The authors believe that openness of information about military activities is the key to successful arms control. It is knowledge which creates confidence. Recent progress in arms control between the superpowers only began when they acquired the capability to observe

each other through satellites. The problem with this system is that the information acquired is only available to the state which launched the satellite. Furthermore, the superpowers acquire information on other countries without reciprocity. The authors continue:

> We think it would create a climate of confidence that would contribute to international peace and security if the information from satellite surveillance of military activities was publicly and universally available to all countries. ...
> We therefore propose that a consortium of about a dozen non-nuclear weapon states, with representation from all geographical areas and social systems, should establish a satellite system for the surveillance of the military activities of all countries. The information acquired would be transmitted regularly to the United Nations and would be made available to all on an unrestricted basis in a usable form.
> The consortium might include such countries as Canada, Federal Republic of Germany, Japan, Sweden, Yugoslavia, Poland, Mexico, Venezuela, Nigeria, Tanzania, India, Singapore, etc....
> Until an independent launch capability is available, the United States and/or the Soviet Union should provide launch services.

PROPOSAL ABSTRACT H49(G78)

1. Arms Control Problem:
   Any arms control problem

2. Verification Type:
   a) Remote sensors - **satellite**
   b) International exchange of information
   c) International control organization

3. Source:
   France, "Proposals of France for inclusion among the final draft documents (declaration, programme of action, machinery for negotiations) of the special session of the United Nations General Assembly devoted to disarmament", Preparatory Committee for the Special Session of the General Assembly devoted to disarmament, A/AC.187/105, 23 February 1978.
   See also: A/S-10/AC.1/7, 30 May 1978.

   Note: **General Assembly Resolution of 14 December 1978** (A/RES/33/71J) requested the Secretary General to undertake a study of the technical, legal and financial implications of establishing an international satellite monitoring agency.

4. Summary:
   In the February document, the French representative

stated:

> France considers that the international disarmament effort should benefit from the progress made in the technology of observation by satellite. Information useful for the strengthening of security and trust which can be obtained in this way should be placed at the disposal of the interested states, in accordance with political, legal and technical modalities to be agreed upon by consensus by the international community.
>
> It therefore proposes the establishment of an International Observation Satellite Agency. The Agency which would be directly responsible to the United Nations, would have as its task the collection (by means which it might possess in its own right as well as others), the organization and the dissemination of data obtained by satellite in fields directly affecting security and the control of agreements.

At the United Nations Special Session on Disarmament the French government elaborated on its satellite proposal. Because earth observation technology had advanced greatly and further progress seemed likely, it is important to place this new monitoring technology at the service of the international community for supervision of arms control agreements and for strengthening international confidence. In addition to monitoring arms control undertakings, the information gathered by observation satellites could provide essential elements for settling disputes between states by permitting more satisfactory assessment of the facts which give rise to such confrontations.

The French note outlines several guiding principles for the ISMA. Its role would be to collect, process and disseminate information secured by satellites. There would also be a provision in its charter to ensure that information collected by the Agency would be used only for the performance of its tasks.

The functions of the ISMA would include, first, monitoring implementation of arms control agreements and, second, investigations of specific situations. Regarding the first function, a survey of arms control agreements already in force would be made in order to determine the extent that satellite monitoring could apply. If it was found to be applicable to an agreement the Agency would offer its services to the parties. In the case of future arms control and security agreements the Agency might prepare standard clauses for inclusion in such treaties. Provision might also be made for regional international organizations to solicit the Agency's services.

Regarding the second function of the ISMA, a state could report to the Agency when it felt its security jeopardized by another state. The Agency would then obtain permission from the state to be investigated before proceeding with

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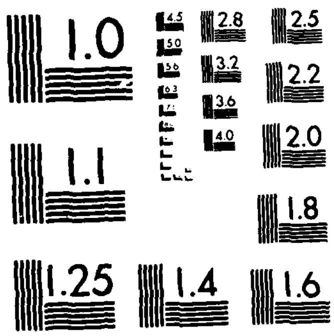

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

any investigation. The Security Council might also take action under Article 34 of the United Nations Charter in such a situation.

France proposes that the ISMA be part of the United Nations system as a specialized agency. Membership of the Agency would be open to any state member of the United Nations or specialized agencies. Organization of the decision-making and deliberative bodies of the Agency would include a plenary organ as well as a restricted organ having balanced representation from all regions of the world. The Agency staff would include the technical personnel needed to process and analyze the data collected.

Because of the complexity and costliness of satellite observation, France suggests that the technical resources of the Agency be gradually expanded as the functions assigned to the ISMA grow. Consequently, to begin with, the ISMA would rely on data provided by states already possessing observation satellites. To ensure autonomy of the Agency, it should possess an independent capacity to interpret the data received.

France suggests that there be three stages to the expansion of the agency:

Stage 1 - a centre for processing data supplied by states having observation satellites,

Stage 2 - data receiving stations to be directly linked to the observation satellites of those states, and

Stage 3 - ISMA observation satellites.

Financing of the ISMA should come from several sources: mandatory payments, voluntary payments, and funds paid in return for Agency services, especially for monitoring arms control agreements.

Some means of settling disputes between the Agency and states or between states should be provided in the ISMA charter. France suggests an arbitration committee be established.

PROPOSAL ABSTRACT H50(A80)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Remote sensors - satellite

3. Source:
   Tsipis, Kosta. "Technical, operational and policy considerations and alternatives for the use of satellite observation data for security purposes". Cambridge, Mass.: Massachusetts Institute of Technology, Department of Physics, March 1980. (Mimeographed).

4. Summary:

Satellites with reconnaissance capabilities could be used for several missions including:

1) verification of compliance with international agreements,
2) reassurance as an inducement to enter into agreements,
3) surveillance as a deterrent to violations of agreements,
4) attack warning/conflict anticipation for preventive diplomacy,
5) evidence of aggression such as border violations for adjudication,
6) monitoring of demilitarized zones and cease-fires, and
7) communication with international observers.

Such a crisis management satellite network could be applied to several adversary situations. The system would consist of one or more satellites capable of acquiring, storing and transmitting ground imagery at optical wavelengths and possible side-looking radar imagery. Sensor complement, resolution and orbital parameters would be dictated by operational requirements. Memory capacity, rate of transmission to ground stations, and image interpretation and dissemination procedures would be influenced by receiver locations and the emphemeral nature of targets. There is no question such a satellite system is technically feasible at present.

The system has three main parts: the satellite, the sensors and electronic links to and from the sensors, and the receiving and processing ground station. Technical aspects of these components are considered by the author in some detail. A number of questions and key policy implications are then discussed, including:

1) Will imaging be performed routinely or only under exceptional circumstances? Routine monitoring could collect a great deal of information unrelated to the mission of the system and thus raise political problems.
2) Will the satellite image all terrain it overflies, or only a few areas per orbit? The former approach will increase technical demands on the system.

3) Will the data be unencrypted and in real time? Real time unencrypted data could lead to charges of violation of state privacy.
4) Should satellite manoeuvres and sensing be first approved by an international body or should national agencies be permitted to perform these functions on a time-sharing basis? National access could reduce time available to any particular nation and raise possibilities of abuse of the system.
5) In what form will the data be disseminated; how extensively will the data be interpreted before disseminated? Raw data would provide high confidence but the burden of interpretation would penalize underdeveloped states.
6) To whom and under what circumstances should data be disseminated? Public dissemination could cause political problems. Dissemination only to parties in a dispute would protect privacy.

Each satellite might cost about $100 million (US, 1977) while a monitoring station would cost less than $10 million per annum. Administrative costs would be about $7 million per annum.

Several organizational structures for the monitoring satellite agency are presented and discussed including:

1) a two-component organization consisting of an International Verification Laboratory (IVL) and an international body of mediators to authorize imaging and dissemination of data,
2) unrestricted sale of imagery by the IVL, or
3) open-channel real-time telemetry receivable by anyone with a receiver.

Several possibilities for organizational sponsorship are also discussed including:

1) international sponsorship such as by the UN,
2) neutral nation sponsorship, and
3) unilateral great power sponsorship.

H51(A80)

PROPOSAL ABSTRACT H51(A80)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) Remote sensors - satellites
   b) International control organization

3. Source:
   Thirty-Fourth Pugwash Symposium. "An International Agency for the Use of Satellite Observation Data for Security Purposes". Report from the symposium held 14-17 April 1980 in Avignon France. Pugwash Newsletter 17, no. 4 (April 1980): 89-97.

4. Summary:
   At present information from earth observation satellites is collected and processed by the USSR and the USA and this technology has played an important role in the verification of bilateral arms control agreements between these two states. The potential usefulness of this technology to the international community as a whole is great - in the field of verification of multilateral arms control agreements, in supporting UN peacemaking and peacekeeping efforts and in the field of international crisis management on a local or global basis. It also has great importance in the economic and social fields. Several other countries now have the capability to operate earth oriented data acquisition systems and more will follow within the next five to ten years.
   Technological Aspects:
   1) Background Technology: A number of technologies currently available in several industrialized countries without recourse to either superpower can be integrated into a total information delivery system within reasonably short order, given the resources and will. A development and test period of five to seven years appears sufficient for initial deployment.
   2) Particular Techniques and Their Application:
      a) Panchromatic optical digital imagers with resolutions of some three metres can be used in daylight.
      b) Infra-red optical sensors with resolutions of approximately 50 metres, complement the above and can operate at night.
      c) Imaging microwave systems (radar) with resolutions of 10 metres, provide all-weather day-night observation.
      d) Non-imaging radar used in the altimetry mode can build up three-dimensional models of terrain.
      e) Satellite-based ground sensor interrogation, location and relay systems continually reporting to a central station are feasible. Ground sensors could be fixed or mobile.

3) Trade-offs:
   It is necessary to trade-off different technical capabilities.
4) Applicability to International Secruity Enhancement:
   a) Sensors of the above types can provide reasonably unambiguous data on significant facilities representing relatively slow changing capabilities and can monitor rates and direction of changes.
   b) Movement of men and materials can be observed with low ambiguity when traffic is concentrated and directional.
   c) The existence and location of relatively static forces or material stocks may be observed but probably not measured without significant ambiguities.
   d) Many classes of events and items of international security interest are not observable from space although circumstantial activities may be. Among these non-observable events are normal industrial processes in existing indoor facilities, infiltration of men, and the purposes of generally used vehicles or facilities. In addition, countermeasures (camouflage and deceptive actions) can defeat satellite observation.
5) System Concept:
   a) Space Segment: Three spacecraft each carrying a different type of sensor would be the most efficient mode. The satellites would have angular manoeuvreability and altitude change capabilities but would be unable to change their plane.
   b) Ground Segment: This would be composed of a secure data acquisition, processing and disseminating centre. Some back-up systems may be needed in certain circumstances.
   c) Operational Characteristics: Operations would cover static situations, slow rate of change situations and rapidly evolving situations. From notification to initial output of the system, the time span is estimated at two to three days.
6) Technical Development Forecast:
   In the next 20 years several technical improvements (see source) will occur which will allow improved observation capabilities. The design, development, testing and execution of a new satellite system takes five to seven years. The second generation of satellites should duplicate the first to ensure continuity of operations. The third generation should be subject to a review of experience achieved so far and of new technologies.

Costs:

Costs are estimated as follows:

Space segment $1 - 1.5 billion
Ground segment $200 million
Running costs $125 million per annum

H51(A80)

Role and Functions:

The data acquired by the satellites should be made available under agreed rules and procedures in accordance with the UN Charter. Several applications are foreseen for the data including verification of compliance with arms control agreements. Some participants in the symposium maintained that satellite observation is useful in strategic arms limitation when the parties do not camouflage their activities, while for many tactical situations confusing detail would make satellite data of limited value. Most did not share such views but, nevertheless, agreed that the satellite system could not itself provide answers to all the problems. The system should be considered within a wider network of arrangements designed to promote confidence and security.

Constitutional Considerations:

Most participants felt it desirable that the satellite system be part of the UN, some feeling that an internal organ linked to the Security Council had the best chances of enlisting the co-operation of the superpowers. Two other models include:

a) the Western European countries taking the initiative, with more countries joining later, and

b) a group of "neutral" countries operating the system.

Even without superpower assistance the satellite system could be developed.

Political and Legal Considerations:

Each state or group of states has the right to acquire information necessary for its security by any means permitted under international law. The international community, despite periodic opposition, has more or less accepted the existing situation as far as military and earth resources satellites are concerned. Dissemination of information, however, poses special political and legal difficulties. These relate principally to the sensitivity of the data, its safe storage and confidentiality, and its objective interpretation and fair dissemination.

CHAPTER I

SEISMIC SENSORS

Seismic monitoring as a verification technique is most frequently discussed in the context of a nuclear test ban. In this sense, seismic monitoring involves recording and analyzing ground shock waves at a considerable distance from the event. While such seismic devices could accurately be described as remote sensors and therefore included in Chapter H, because of the number of proposals abstracted and the restricted utility of the method, a separate chapter has been created. It should also be pointed out that short-range seismic detectors also exist which are discussed in chapter G.

There are three main requirements for seismic monitoring. First, to detect a seismic event; second, to locate it; and third to identify whether it represents a natural event or a nuclear explosion. Because of limitations on equipment sensitivity there is a threshold magnitude of event which is detectable. Location of an event usually demands detection at two or more distantly separated locations, i.e. a detection network, and identification depends on the shock wave pattern or "signature" of the event.

The magnitude of the shock produced by a nuclear explosion varies according to its location and the type of earth or rock in which it is detonated. There is some controversy over the minimum size of nuclear burst which can be detected and also over how far it is possible to disguise the "signature" of a burst to simulate a natural event.

Many countries possess seismic dectection stations for earthquake monitoring and there are international data exchange networks, notably the "World Wide Standard Seismograph Network" (WWSSN) completed in 1967. However the USSR and several of its neighbours are not members of the network, leaving a large gap in its geographic coverage.

The partial nuclear test ban agreement does not include specific provision for verification although it is written so as to ban only those explosions which it was believed could be detected. A very large proportion of the verification proposals in this chapter have been concerned with converting the limited test ban into a comprehensive test ban or at least extending the range of explosions banned, and with introducing adequate verification for it. Whether an officially accepted and internationally operated verification network would be a great improvement over the unofficial system now operating is a matter for debate, but undoubtedly it would be an advantage if all nations adhered to the test ban treaty and accepted a uniform verification system.

It seems clear, however, that there is little likelihood of devising a system capable of detecting and identifying by remote sensors all nuclear explosions however small.

Contents of Chapter I*

Arms Control Objective	Number of Proposal Abstracts
Nuclear weapons	39

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* A list of technical working papers on seismic monitoring delivered in the ENDC, CCD and CD which have not been abstracted here can be found at the end of this volume.

PROPOSAL ABSTRACT I1(G75)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions

2. Verification Type:
   a) Seismic sensors
   b) On-site inspection - selective
   - IAEA safeguards

3. Source:
   Japan, "...arms control implications of peaceful nuclear explosions", CCD/454, 1 July 1975.
   See also: CCD/PV. 776, 2 March 1978.
   CD/PV. 16, 6 March 1979.

4. Summary:

The onus of showing an explosion to be that of a peaceful nuclear device is on the party conducting it. Therefore all PNEs should be registered in advance giving details as to proposed purpose, procedures (yield, nature, device, geological information, etc.) and data which the state is prepared to make available to the world community resulting from the test. Possible verification methods include:

1) seismic monitoring (i.e. certain types of PNEs might have characteristic signatures);
2) on-site inspection in order to identify the design of the device, and other characteristics of the PNE; and
3) IAEA safeguards together with use of nuclear material derived from a safeguarded fuel cycle which would at least tell what type of device and the amount of nuclear material that was used.

Certain types of PNEs will be more difficult to verify than others.

In CCD/PV. 776 Japan contends that because of the danger of nuclear proliferation, nuclear explosions for peaceful purposes should never be conducted unless agreement is reached upon international observation procedures. It therefore recommends that a provision be included in any CTB agreement to this effect and that states also undertake in the treaty to continue negotiation in good faith on appropriate international supervision.

PROPOSAL ABSTRACT I2(G72)

1. Arms Control Problem:
   Nuclear weapons - partial test ban

2. Verification Type:
   Seismic sensors

3. Source:
   Japan. CCD/PV.553, 28 March 1972.
   See also: Canada, Japan, Sweden. "Working paper on measures to improve tripartite cooperation among Canada, Japan and Sweden in the detection, location and identification of underground nuclear explosions by seismological means". CCD/376, 20 July 1972.

4. Summary:

Japan proposes an expert meeting to deal with the establishment of a permanent international seismic network to monitor a test ban. The purpose of the meeting would be to select stations and their locations, to select a method of data exchange, to designate coordinating centres for the collecting and storing of data, and to determine methods for preventing intentional alteration of data.

In the interim period, before the network is established, Japan calls for a commitment by the two superpowers not to test above a threshold of m_b 5.75. To verify compliance Japan proposes the use of a tripartite seismograph network of Canadian, Japanese and Swedish stations. CCD/376 of 20 July 1972 presents the results of a trilateril conference of Canada, Japan and Sweden to establish this seismic network.

I3(T74)

PROPOSAL ABSTRACT I3(T74)

1. Arms Control Problem:
   Nuclear weapons - partial test ban

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors
   c) International exchange of information (Protocol)
   d) Complaints procedure - consultation and cooperation- (Article 2 (3))

3. Source:
   United States/Union of Soviet Socialist Republics. "Text of the Treaty between the USA and USSR on the limitation of underground nuclear weapon tests and protocol". (Threshold Test Ban Treaty). CCD/431, 16 July 1974.
   Signed: 3 July 1974.
   Submitted for ratification - to US Senate: July 29, 1976
   - To USSR Supreme Soviet: August 11, 1976.

4. Summary:
   The Treaty prohibits underground tests exceeding 150 kt. As well, all future military tests are to be limited to specific test sites. For verification purposes "national technical means", presumably seismic monitoring and satellites, are to be used (Article 2(1) and (2)). Parties are also obligated not to interfere with the other party's national verification means. This presumably also entails a prohibition on use of evasion techniques.
   The protocol provides for an exchange of detailed information on the basis of reciprocity, concerning:
   1) location of test sites,
   2) geology of the sites,
   3) geographic coordinates of the test after they are conducted, and
   4) yield, data, time, depth and location of two calibrating tests for each test site.

5. Selected Comments by States:
   The Treaty (TTBT) has been criticized because the threshold above which tests are prohibited is so high. Sweden* has claimed that only 10-20 percent of the nuclear tests conducted in the past by the two superpowers have exceeded 150 kt. The present seismic identification threshold is much lower than this, around 10 kt.

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* PV. 647, 30 July 1974.

PROPOSAL ABSTRACT I4(A58)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   Seismic sensors

3. Source:
   Orear, J. "The Detection of Nuclear Weapons Testing". In Inspection for Disarmament. Edited by Seymour Melman. New York: Columbia University Press, 1958.

4. Summary:

This proposal calls for the establishment of twenty-five seismic monitoring stations in the USSR and seven in the United States, each station to monitor a 300 mile range. This would mean that any test would be within 300 miles of at least one station and within 600 miles of twelve stations.

Alternatively, a range of 500 miles could be used, although there would be a need for additional stations in seismic belts. Stations should be located in non-restricted areas and the personnel operating the stations should be confined to them so that no charge could be raised that a state's security was being jeopardized.

Finally, all presently existing seismic stations should be required to submit copies of their records to the international inspectorate. This might allow for a reduction in the number of monitoring stations.

PROPOSAL ABSTRACT I5(G62)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
2. Verification Type:
   a) Seismic sensors
   b) On-site inspection - selective
      - non-obligatory
   c) International control organization
3. Source:
   Brazil, Burma, Ethiopia, India, Mexico, Nigeria, Sweden, United Arab Republic. "Joint memorandum". ENDC/28, 16 April 1962.

4. Summary:

   There exists the possibility of establishing a system for continuous observation and effective control on a purely scientific and non-political basis. Such a system might be based upon already existing national networks of observation posts and institutions together with new posts established by agreement.

   An International Commission consisting of a limited number of highly qualified scientists with appropriate staff might be considered. This Commission would process data received from the system of observation posts. All parties would agree to furnish data to the Commission regarding the nature of any suspicious and significant event. Parties could invite the Commission to visit their territory and/or the site of a suspicious event. If the Commission remained uncertain as the nature of the event the party and the Commission would consult regarding further measures of clarification. After full examination of the facts the Commission would inform the parties to the treaty of its assessment of the event in question.

5. Selected Comments of States:

   The US raised several questions regarding the details of the proposed system, see: ENDC/29, 17 April 1962. The USSR supported the position taken in this paper in ENDC/32 of 19 April 1962.

PROPOSAL ABSTRACT I6(G62)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   Seismic sensors

3. Source:
   United States. "Report by the United States Department of Defense, dated 7 July, on Project Vela". ENDC/45, 16 July 1962.

4. Summary:

This paper reviews the findings of an intensive research and development program directed at improving methods of detecting underground nuclear explosions. The topics reviewed include deep bore-hole seismographic instruments, surface arrays, ocean-bottom seismometers and seismographic techniques for locating and identifying tests.

PROPOSAL ABSTRACT I7(G65)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information
   c) International control organization

3. Source:
   Sweden. "Memorandum on international cooperation for the detection of underground nuclear explosives". ENDC/154, 2 September 1965.
   See also: ENDC/PV. 222, 10 August 1965.

4. Summary:

The paper proposes the creation of a "detection club" to extend international cooperation in seismology for the purposes of detection of underground blasts. The paper is concerned only with the detection aspect of seismic verification.

Despite improvements in seismic monitoring, few nations, if any, would have the capability to monitor signals over the entire globe. To enable all states to monitor a CTB treaty, data from several seismic stations widely

distributed and suitably sited would have to be made available.

The "detection club" would be essentially an international data service, providing access to first class data for independent analysis. If such cooperation began before the test ban enters into force, research on remaining verification problems would be facilitated.

The data should preferably come from good instruments at well chosen, globally distributed sites. Such a network could, if necessary, be based on data from selected stations in a small number of countries. It might be desirable, in order to heighten a potential violator's uncertainty, to keep some stations outside the network.

The data exchanged should be in the form of short bulletin-like messages. Results of calculations on the data should also be included. Records would be exchanged on request.

Another important element of the system is the adoption of standards for instrumentation and data formats. It might be necessary to establish some international coordinating body to cope with the large amount of data generated by existing and projected seismic stations.

Given the existence of scientific data exchange networks the specific needs of a "detection club" might in some cases require only adjustments of present national and international efforts. Use might be made of existing global telecommunications networks (e.g. the World Meteorological Organization's network). Coordination with existing global seismological cooperative efforts would also be desirable.

PROPOSAL ABSTRACT I8(G67)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information
   c) On-site inspection - selective

3. Source:
   Sweden. "Memorandum on the control of an underground test ban treaty". ENDC/191, 19 July 1967.

4. Summary:

The paper describes an analysis of the utility of a number of techniques for verifying a CTB. The analysis involved an application of "decision theory". It was assumed, as a starting point in this analysis, that a basic control system would have to meet two political requirements:

1) It should provide adequate deterrence against violations by making the probability of discovery sufficiently high; a discovery probability of 10 percent being rated as sufficiently high.
2) It should provide adequate assurance against the risk that a false alarm would induce unwarranted accusations.

The results of the analysis showed that some of the seismic identification methods suggested in the open literature are of limited efficiency. However, the British teleseismic method of "identification by complexity" suggests the possibility of a control system incorporating no more than one on-site inspection in two years. A similar number of inspections would be required using a U.S. identification method employing regional data perhaps obtained through an international data exchange. If these two seismic methods were combined the number of inspections required might be further reduced.

Given such improved seismic identification methods it is possible to talk of control without inspection.

PROPOSAL ABSTRACT I9(G69)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - peaceful nuclear explosions

2. Verification Type:
   a) Seismic sensors - (Article 2(2))
   b) International exchange of information (Article 2(2))
   c) On-site inspection - selective
      - non-obligatory (Article 2(3))
   d) Complaints procedure - consultation and cooperation (Article 2(3))
      - referral to Security Council (Article 2(4))
   e) Review conference (Article 5 of CCD/348)

3. Source:
   Sweden. "Working paper suggesting possible provisions of a treaty banning underground nuclear weapons tests". ENDC/242, 1 April 1969.
   See also:
   - ENDC/PV. 399, 1 April 1969;
   - ENDC/PV. 415, 23 May 1969;
   - CCD/PV. 524, 27 July 1971; and
   - CCD/348, 7 September 1971 which is a revised version of ENDC/242.

4. Summary:

The aim of the original draft treaty (ENDC/242) and its revision (CCD/348) is to prohibit underground nuclear tests. Parties are also obligated to conduct peaceful nuclear explosions in conformity with international agreements to be negotiated (Article 1).

The main components of the verification system are found in Article 2. According to this provision, each party is under a general obligation to cooperate in good faith to implement the treaty (Article 2(1)). More specifically, parties are to cooperate in an "effective international exchange of seismological data" (Article 2(2)). Parties are also required to clarify any events pertaining to the subject matter of the treaty. In this regard each party is entitled to:

a) make inquiries and receive information as a result of such inquiries,
b) invite inspection of its territory (such inspection to be conducted in a manner prescribed by the inviting party), and
c) make proposals as to how to clarify any doubts

remaining after the application of the preceding provisions (Article 2(3)). Should the party under suspicion fail to fully cooperate, a complaint could refer the matter to the Security Council (Article 2(4)).

Concerning the revisions incorporated into the proposal by CCD/348, only minor modifications are made to the verification article requiring more detailed provisions for an interim seismic data exchange network (Protocol 1), for a permanent seismic data exchange network (Protocol 3), and for an exchange network concerning PNEs (Protocol 2). The revised draft treaty also incorporates a provision for a review conference (Article 5).

The basic proposal rests on two assumptions:

1) that the rate of false alarms would be low (1 per decade), and
2) that improved seismic detection capabilities, deriving particularly from international exchange of seismic information would be sufficiently powerful to deter potential violators. Sweden contended that a 10% risk of disclosure was sufficient for deterrence and claimed a 50% chance of detection for its system.

Also implicit in the basic proposal described here is the concept of "verification by challenge". This system involves challenging a suspected violator to clarify the nature of any uncertain seismic event. One method of clarification would be to voluntarily invite the complainant to inspect the site of the event.

PROPOSAL ABSTRACT I10(G69)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - partial test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information
   c) International control organization

3. Source:
   Japan, ENDC/PV. 424, 31 July 1969
   See also: ENDC/PV. 416, 3 July 1969.

4. Summary:

A CTB treaty should be accomplished in two steps. First, the nuclear weapon states would agree to prohibit underground tests above seismic magnitude 4.75. According to the consensus at a SIPRI meeting in the summer of 1968 there is almost a 100 per cent certainty of detecting a blast over this magnitude. Uncertainty remains for any event below m_b 4.0 (equivalent to a 2 kiloton explosion in granite, 6 kt in tuff, or 25 kt in partially saturated alluvium). This first step would include a commitment by the parties to cooperate with each other in order to devise within a certain period of time a system of verification which would be capable of monitoring explosions below m_b 4.0. The second step would be a complete ban on underground nuclear tests when a system of verification had been worked out.

International exchange of seismic data would play an essential role in both the limited and complete test bans. There is a need to examine present seismic observatories and international exchange of data. There also is a need to standardize measurements and to designate certain observatories to provide data. All states should agree to make seismic data internationally available on a daily basis. This exchange would include complete seismic records to ensure credibility of the data.

An international centre would be required which would report the data promptly to parties since speed is of critical importance.* In addition to this quick reporting centre it would be necessary for another international monitoring centre to objectively analyze seismic

* Reference is made to similar statements by the UK and by Canada in ENDC/PV. 404, 17 April 1969.

data. This center would have four main functions:

1) to examine reports of the quick reporting center,
2) to collect necessary data on suspicious events,
3) to analyze data and determine which events were explosions and which earthquakes, and
4) to regularly supervise the operations of national observatories which were registered as part of the international seismic monitoring system.

PROPOSAL ABSTRACT I11(G70)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information
   c) International control organization

3. Source:
   United Kingdom. "Working paper concerning verification of a comprehensive test ban treaty". CCD/296, 28 July 1970.

4. Summary:

This paper describes in detail a hypothetical international network of 26 seismic stations (seven of which presently exist), the system's capacity to detect and identify seismic events, and its cost. The system envisages 4 stations established in the Soviet Union.

In the Northern Hemisphere 90 percent of all earthquakes down to a magnitude of $m_b 4$ (1-2 kt in hard rock) would be detected by at least 4 stations (location) and 3 stations (identification). For nuclear blasts the threshold would be about $m_b 4.5$ (3-6 kt in hard rock) for identification.

A data collection and collation centre would be established as part of the system to maintain common standards of operation, quality control and reporting. This centre would collate and store data that would be provided to any state party on request. It could also, if desired, present analyses of the data.

The estimated cost of installing the system would

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be £15 million with an operating cost of £5 million per year.† Each country would staff its own stations. It is believed that the system could be established within 5 years.

The paper also cursorily evaluates some evasion techniques ("decoupling", masking during earthquakes, and simulating earthquakes).

PROPOSAL ABSTRACT I12(G70)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Canada. "Working paper concerning seismological capabilities in detecting and identifying underground nuclear explosions". CCD/305, 10 August 1970.
   See also: Sweden. "Technical working paper offering a comparison of two systems for verification of a comprehensive test ban". CCD/306, 12 August 1970.

4. Summary:
   On 17 April 1969* Canada suggested that countries submit to the UN Secretary General, a list of all seismic stations from which they would be ready to supply records for the purpose of monitoring a test ban. The intent was to determine existing resources available for an international seismic monitoring network. This idea was resubmitted in a more formal working paper in May 1969.** Eventually, the proposal was incorporated in General Assembly Resolution 2604 A(XXIV). The paper under discussion here (CCD/305) is an assessment of the returns made pursuant to this resolution.

   Existing seismic data resources available for any international network could detect earthquakes and underground explosions down to m_b 4.0-4.2, occurring in the northern hemisphere at 50% probability. At 90% probability

† This cost estimate is later reduced. See: CCD/351 of 23 September 1971 and CCD/386 of 22 August 1972.

* ENDC/PV. 404.
** ENDC/251. It was revised in August, 1969.

the detection threshold is m_b 4.5-4.7.

Identification is more difficult; the threshold in this case being potentially:

1) m_b 4.0-4.4 for earthquakes at 50% probability,
2) m_b 4.5-4.9 for earthquakes at 90% probability,
3) m_b 5.0-5.4 for underground nuclear blasts at 50% probability,
4) m_b 5.5-5.9 for underground nuclear blasts at 90% probability.

Sweden later introduced a working paper (CCD/306) comparing the system suggested by the UK paper (CCD/296, abstract (I11(G70) and that suggested by Canada (CCD/305), giving the following capability for both in terms of blast yields:

	Cdn paper's System	UK's 26 Array System
Detection threshold	8 kt	3 kt
Identification threshold	90 kt	12 kt*

The difference between the systems is attributed mainly to the large number of long period arrays included in the UK system and also to the fact that the two working papers used different criteria to calculate the thresholds. In the UK paper, parallel use of a number of identification methods was proposed, whereas the Canadian paper considered only one.

* If stations in the USSR are excluded the threshold rises to 20 kt.

PROPOSAL ABSTRACT I13(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) Short-range sensors - monitoring devices

3. Source:
   Japan. CCD/PV. 497, 2 March 1971.
   See also: - Mexico. CCD/PV. 504, 25 March 1971.
   - Japan. CCD/PV. 801, 17 August 1978.
   - Japan. CD/PV. 16, 6 March 1979.

4. Summary:
   Japan here resurrects the notion of using automatic seismic stations ("black boxes") to monitor a test ban. Mexico took up the Japanese idea and referred to the 1962 Soviet proposal to install on its territory two or three automatic seismic stations.* These devices would have been installed and maintained by Soviet personnel. Mexico called on the USSR to renew its proposal and on the USA to accept the idea as a basis for negotiation.

5. Selected Comments of States:
   The Soviet Union** reacted to this call by pointing to the American rejection of the earlier proposal and by claiming that there was no evidence that reopening the discussion on black boxes would be fruitful.
   The USA in a number of statements*** asserted that it was continuing to conduct research on the feasibility and problems of developing tamper-resistant, tamper-indicating, low maintenance, unattended seismic observatories. The American position on "black boxes" on the basis of this research was that while they might be a useful addition to verification capabilities, they were not equivalent to on-site inspection.

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* ENDC/Sc. 1/PV. 43.

** CCD/PV. 536, 7 September 1971.

*** See for example: CCD/PV. 580, 24 August 1972 and CCD/404, 5 July 1973.

PROPOSAL ABSTRACT I14(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors - satellites

3. Source:
   Netherlands. "Working paper concerning seismic detection and identification of underground nuclear explosions". CCD/323, 18 March 1971.
   See also: CD/7, 1 March 1979.

4. Summary:

The Netherlands summarizes its view of existing capabilities for seismic monitoring in the Northern Hemisphere as follows:

1) Explosions can be identified with a "reasonable probability" down to a seismic magnitude m_b 5.5 or a yield of about 50 kt in hard rock.
2) Earthquakes can be identified above m_b 4.8-5.1 with a high degree of confidence.

The working paper then lists three technical methods of improving seismic identification including new methods of analysis and new equipment. By using these techniques it is suggested that the identification threshold can be lowered perhaps to a level of 10 kt in hard rock.

The paper also suggests that both cratering after a blast in dry soil and the extensive mining operations necessary for seismic decoupling of blasts in hard rock are probably detectable by satellite observation. This is important in reducing the possibility of evading a test ban.

In March of 1979, the Netherlands introduced a technical working paper (CD/7) entitled: "On the use of short-period initial motion data for discrimination purposes".

I15(G71)
I16(G71)

PROPOSAL ABSTRACT I15(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information
   c) Complaints procedure - referral to Security Council
   d) Review conference

3. Source:
   Egypt. CCD/PV. 509, 20 April 1971.

4. Summary:
   All countries should have the ability to obtain rapidly and easily seismic data of concern to them. Therefore the principle of "exchange of data through cooperation" should be recognised in a CTB treaty. But obtaining data on a continuing basis is not itself sufficient; a complaints procedure is also needed. The treaty should include some form of verification by challenge, recourse to the Security Council, mention of a review conference and a withdrawal clause.

PROPOSAL ABSTRACT I16(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Sweden, CCD/PV. 513, 4 May 1971.

4. Summary:
   Reference is made to a previous Swedish proposal concerning the use of standardized seismic stations in national networks with agreed norms of operational performance and data acceptability. Such a network of national stations would be an efficient base for an international seismic data exchange. It would provide the same kind of data but in more extensive form than a few "black boxes". The credibility of such data, of course, depends on the professional integrity and reputation of the scientific institutes operating the stations.

PROPOSAL ABSTRACT I17(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   Seismic sensors

3. Source:
   Canada. "Working paper on the seismological detection and identification of underground nuclear explosions". CCD/ 327 and Add. 1, 29 June 1971.

4. Summary:

The paper comes to the following conclusions, amongst others:

1) The identification threshold of Eurasian underground explosions using existing networks is 20 kt except in dry alluvium, where the threshold rises.
2) The identification threshold of North American explosions is 10-20 kt but with new techniques this could be reduced to 5-10 kt except for dry alluvium.
3) A corresponding reduction in the identification threshold for Eurasia requires deployment of a limited number of improved single stations, together with a merging of currently available data.
4) Reduction of the threshold to 1-2 kt except for dry alluvium would require massive investment in arrays situated on the same continent as the events, plus improved analytical techniques.
5) Concentrating on existing test sites simplifies the identification problem. Estimates for universal coverage are always more pessimistic than capabilities for specific test sites.
6) The practical potential of a 5-10 kt threshold is possible because of modern standard seismograph networks, deployment of arrays by a number of countries, the work of a number of countries on experimental improved single stations, and the ready or potential availability of data from all these.

5. Selected Comments of States:

   The paper was interpreted by the United Kingdom* as suggesting that rather than establish a special network for test ban monitoring, it would be better merely to improve the existing World-Wide Standardized Seismic Network.

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* See CCD/486, 12 April 1976.

PROPOSAL ABSTRACT I18(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Italy. "Working paper on underground nuclear blasts". CCD/331, 1 July 1971.

4. Summary:

Suggested improvements in international detection and identification techniques include:

1) Establishment of an international centre for coordination of research, dissemination of scientific reports on results obtained and data storage.
2) Subdivision of each continent into zones with their own centres responsible for data gathering and processing and execution of study programmes.
3) Commitment by national authorities to bring their existing observatories into line with agreed standards, and, when necessary, to remedy any deficiencies.
4) Commitment by governments to bear operational equipment and research costs and to lend their assistance in the improvement of a world wide seismological network.

PROPOSAL ABSTRACT I19(G71)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   Seismic sensors

3. Source:
   Japan. "Working paper...concerning the usefulness of the employment of ocean bottom seismographs and a universally acceptable means of determining the magnitude of seismic events...". CCD/345, 24 August 1971
   See also: "Working paper on problems in determining the body wave magnitude". CCD/399, 24 April 1973.

4. Summary:

Improved teleseismic capability requires that detection techniques be improved to match the level achieved by the recent development of better analytical methods. Japanese research suggests that the inherent limitations of detection capabilities of land based seismographs can be circumvented by extending the seismic network to the ocean floor. On the sea-bed background noise levels have been found to be less than half that of the quietest land sites. This quietness is neither affected by weather nor subject to seasonal changes. It is suspected that even a single oceanbottom station could detect seismic events at an equivalent sensitivity level to that of a fairly large array station on land. Such ocean bottom stations could, with improvements, be used to locate and identify seismic events.

Present instrumentation is such that seismographs can be sent to depths of several thousand meters and operated for two to five months without maintenance. Data is stored on magnetic tape and could be retrieved when necessary. Furthermore there is no problem over intruding into sovereign territory if the instruments are placed below the high seas.

The working paper goes on to suggest in detail a possible universally acceptable means of determining the magnitude of seismic events.

I20(G73)

PROPOSAL ABSTRACT I20(G73)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Canada. "The verification of a comprehensive test ban by seismological means". CCD/406, 10 July 1973.

4. Summary:

The paper reviews the status of Canadian seismic research and discusses existing uncertainties in seismic verification. It comes to the following conclusions, amongst others:

a) There is a 90% chance of applying seismic discrimination techniques to events as low as body wave magnitude m_b 4.5 (5-10 kt in hard rock assuming no evasion).
b) The current teleseismic limit for positive identification in rock is about 2 to 4 kt. Thus other operational verification techniques need practical consideration including on-site inspection.
c) Ignoring evasion possibilities, the rate of false alarms using purely seismological methods depends upon the operational methods adopted, the discrimination limit of the deployed network and a policy decision about what constitutes adequate deterrence.
d) The provision of seismic data from all Eurasian states would enable progress to be made on the residual false alarm problem.
e) Currently, a multistep discriminant approach to an operational verification scheme involving multinational cooperation between advanced national facilities appears to provide an attractive way to monitor underground nuclear explosions and could be developed for the purpose of a CTB.
f) As seismic limits are reached more emphasis will be necessary on cost-effective seismic array monitors using small scale digital processors and on devising optimum methods of verification.

PROPOSAL ABSTRACT I21(G73)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors - satellites
   c) International exchange of information
   d) On-site inspection - selective
   \- non-obligatory

3. Source:
   Sweden, CCD/PV. 614, 19 July 1973.
   See also: "Working paper reviewing recent Swedish scientific work on the verification of a ban on underground nuclear explosions". CCD/405, 10 July 1973.

4. Summary:

Seismic monitoring techniques provide sufficient probability of detection, for effective deterrence. But there is a need for more suitably located modern stations, efficient exchange of seismic data and an international centre to receive data, locate events and redistribute information to the parties.

Satellite verification can provide valuable supplementary information to that of the primary verification method (i.e. seismic monitoring). Satellites can monitor small scale activities within selected and limited areas such as known or suspected underground test sites. This adds an extra burden to potential violators. Satellites could play a useful role in avoiding false alarms by confirming the absence of human activities at a suspended test site. Sweden advocates international control over such observation satellites.

On-site inspection should be used not as the primary means of control but as a follow-up method for events that are detected and located but not identified. The exact nature, and the frequency of inspections required is not clear. Preferably they would be conducted only on invitation. Nevertheless, even without on-site inspection sufficient deterrence can be achieved to prevent violation.

I22(G73)
I23(A74)

PROPOSAL ABSTRACT I22(G73)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Netherlands. "Some observations on the verification of a ban on underground nuclear test explosions". CCD/416, 28 August 1973.

4. Summary:
   The paper comes to the following conclusions:
   1) Obligatory on-site inspections would not enhance identification possibilities significantly.
   2) Realistic possibilities of evading an underground test ban seem to exist for yields up to 10 kt. Significant improvements or extension of seismological hardware will probably not change this. On the other hand, improvements in counter-evasion techniques like spectral analysis, matched filtering and measurement of focal depth could be quite helpful.
   3) An intensified international exchange of those seismic data which are used for identification of events is needed on a routine basis.

PROPOSAL ABSTRACT I23(A74)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) Complaints procedure - consultative commission

3. Source:
   Scoville, H. "A Leap Forward in Verification". In SALT: The Moscow Agreements and Beyond, pp. 160-182. Edited by M. Willrich and J.B. Rhinelander. New York: The Free Press, 1974.

4. Summary:
   This proposal is based on an understanding that present seismic technology permits detection and identification of all but the lowest yield underground nuclear explosions. It

monitoring and satellites. The parties are also obligated "to cooperate in an international exchange of seismic data" (Article 2(2)). Consultation between the parties when necessary is also included (Article 2(3)).

Should any party ascertain that another party is violating the treaty, it may lodge a complaint with the Security Council providing with the complaint all possible evidence in support of its contention, (Article 2(4)).

It should be noted, as well, that the draft treaty includes a provision which prevents its coming into force until all nuclear weapon states have ratified it. It should also be pointed out that there is no provision for a review conference.

PROPOSAL ABSTRACT I25(G75)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
2. Verification Type:
   Seismic sensors
3. Source:
   United Kingdom. "Working paper on safeguards against the employment of multiple explosions to simulate earthquakes". CCD/459, 24 July 1975.
4. Summary:
   The paper describes a technique of detecting the possible evasion of a CTB. The evasion method of concern is simulation of an earthquake using multiple nuclear explosions. The detection technique involves broad band seismic discrimination. The results of experimentation suggest that one could identify the explosive origin of components within a series of blasts, with yields of 50 kt or more. Further improvements would add to the uncertainty any potential violator must face.

proposes that in order to augment use of such technologies, measures such as those established under Article XII of the 1972 ABM Treaty - that is, use of national technical means of verification, promise of non-interference with these means and promise not to use deliberate concealment measures which impede verification by national technical means - might be useful. Further, the author suggests that a multilateral international consultative commission could be established to provide a forum for obtaining additional clarification. Such measures, he contends, would greatly reduce or even eliminate fears of violations of a comprehensive test ban treaty.

PROPOSAL ABSTRACT I24(G75)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors (Article 2(1))
   b) Remote sensors
   c) International exchange of information (Article 2(2))
   d) Complaints procedure - consultation and cooperation (Article 2(3))
      - referral to Security Council (Article 2(4))
   e) On-site inspection - selective
      - non-obligatory (Article 2(3) of CCD/523)

3. Source:
   Union of Soviet Socialist Republics. "Draft treaty on the complete and general prohibition of nuclear weapon tests". Annexed to UNGA resolution A/Res/3478 (XXX), 1975.
   See also: "Draft treaty on the complete and general prohibition of nuclear weapons tests". CCD/523, 22 February 1977.

4. Summary:

The aim of the draft treaty is the prohibition of the testing of nuclear weapons in all environments (Article 1). This ban, however, is not intended to apply to peaceful nuclear explosions (PNEs) which are to be conducted, in the case of non-nuclear weapon states, according to Article 5 of the Non-Proliferation Treaty and, in the case of nuclear weapon states, in conformity with procedures to be agreed upon between nuclear weapons states with due regard to the recommendations of the IAEA (Article 3).

Verification is to be based on the use of each party's own technical means (Article 2(1)) which presumably means seismic

PROPOSAL ABSTRACT I26(A76)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - peaceful nuclear explosions

2. Verification Type:
   Seismic sensors

3. Source:
   Bolt, Bruce A. Nuclear Explosions and Earthquakes: The Parted Veil. San Francisco: W.H. Freeman, 1976.

4. Summary:

This work focusses on underground nuclear explosions. It is written with the non-expert in mind and covers the following areas:

a) The history of international negotiations regarding a test ban.
b) Background information on the scientific principles involved in nuclear explosions in general as well as specifically those underground.
c) Background information on seismology.
d) Discussion of seismic monitoring capabilities (The identification capability in the Northern Hemisphere was about magnitude 4.5 by 1975 using unclassified seismological networks, according to Bolt).
e) Discussion of evasion tactics such as concealment in natural earthquakes, earthquake simulation, and decoupling.
f) The history and potential of peaceful nuclear explosions (PNEs are likely to prove attractive for excavation of water storage and irrigation and large-scale quarrying purposes, concludes Bolt).
g) The environmental dangers of underground tests.

127(G76)

PROPOSAL ABSTRACT I27(G76)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors - satellites
   c) International exchange of information
   d) Complaints procedure - consultation and cooperation
   e) International control organization

3. Source:
   Sweden. "Working paper on cooperative international measurements to monitor a CTB". CCD/482, 26 March 1976.

4. Summary:

The paper is intended as a discussion of further possible international cooperative measures to facilitate global monitoring of a CTB. It has been shown* that identification capability is improved by combining data from several observatories. The basic idea of the proposal in this working paper is to establish a network utilizing existing or planned seismic installations. Such a network has the advantage of being relatively cheap and of being put into operation easily and rapidly. There would be no requirement for uniform equipment or detection procedures, though the stations must have comparable capabilities. The number of stations would be kept small, thus keeping data to manageable proportions.

The whole system would consist of a global network supplemented by local networks to monitor key areas or areas where evasion might be likely (i.e. alluvium deposits). The paper gives an example of a network consisting of 46 stations in 26 countries including 5 in the USSR.

The parameters extracted from recordings at the stations would be regularly transmitted to an international data centre by telex. Full recordings could be exchanged by mail when necessary. The international data centre would be charged with collecting and analyzing the data. This is a valuable role because many countries possess limited expertise and facilities to carry out such operations. However, the political assessment of the seismic events detected would be left to the parties themselves. The international data centre would also have the function of conducting consultations and inquiries with designated

* See: Canada/Sweden, CCD/380, 27 July 1972; and Japan/Sweden, CCD/441, 13 August 1974.

institutions in order to obtain additional information about events insufficiently described by data routinely obtained. It would also provide experts to observe, by invitation, PNEs and large chemical explosions.

For the small residue of events not identified by the above system, further analysis would be made by acquiring additional seismic data, for example, from local seismic station networks or by applying more refined analytical tecnniques. Satellite photographs of relevant areas could also be requested and analysed. If this did not clarify the event, designated agencies in the country of the event would be consulted. If doubts still remained, the other parties would be left to make their own interpretations and take further steps.

To conduct the tasks described above, a staff of 40 professionals and technicians with appropriate equipment would be required for the data centre. The estimated cost of such a data centre is in the order of $2 million per year. The centre could be set up as an independent body, as part of an existing international body, or it could form a part of an International Disarmament Organization as described elsewhere by Sweden.* The envisaged seismic network would have a detection threshold of $m_b 4$ for Eurasia and North America and slightly above that for the Southern Hemisphere. The identification threshold for earthquakes would approach $m_b 4$ in the Northern Hemisphere.

* See: Sweden. CCD/PV. 601, 15 April 1973 and CCD/PV. 610, 5 July 1973 (Abstract N14(G73)).

I28(G76)

PROPOSAL ABSTRACT I28(G76)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   United Kingdom. "Working paper on the UK's contribution to research on seismological problems relating to underground nuclear tests". CCD/486, 12 April 1976.

4. Summary:

The paper suggests a possible seismic network of 20-25 stations (depending on whether stations in the USSR were included) distributed as evenly as possible over the continents. Each station would be equipped with a British type array of seismometers with digital recordings of its output so that any spectral band of interest could be reproduced. It would not be necessary to resort to the large and expensive arrays for long period instruments specified in CCD/296* since seismometers of existing design might suffice. The choice of sites would be dictated by geology and low noise level criteria rather than by easy logistics. Each control station would be equipped with an array processor. Data would be communicated by either radio or telex to all cooperating centres.

A network such as that above could detect and identify an explosion of between 3 and 50 kt depending on the location of the explosion and chance noise level. If decoupling or other evasion methods were employed, the lower half of the yield band would not be detected at all.

The cost of deploying 20 control posts of the above type would be about £5 million with an operating cost of £25,000 per station per year.

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* See abstract I11(G70).

PROPOSAL ABSTRACT I29(A77)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - peaceful nuclear explosions

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors - satellites
      - ELINT
   c) Short-range sensors - monitoring devices
      - sampling
   d) On-site inspection - selective
   e) International exchange of information
   f) Literature survey

3. Source:
   Dahlman, Ola and Hans Israelson. Monitoring Underground Nuclear Explosions. Amsterdam: Elsevier Scientific, 1977.

4. Summary:
   This book provides detailed coverage of the political and scientific issues surrounding the verification of a comprehensive test ban. It includes chapters on:
   1) The test ban negotiations to 1976 with summaries of the positions of several countries on the issue.
   2) Background information on nuclear explosions.
   3) Background information on seismology and seismic sources.
   4) Description of existing seismic instruments (seismographs, recording equipment, array stations, future developments) and existing networks (national, World Wide Standard Stations Network, array stations. Very-long-period Experiment Stations, Seismic Research Observatories, ARPANET, "black boxes").
   5) Problems and capabilities for signal detection. (The authors conclude that seismic events with magnitudes down to about 4 can be detected over teleseismic distances, but to obtain such a capability a network of stations must be established. To achieve a lower detection threshold, stations at short distances from the even must be employed).
   6) Problems and capabilities for event definition and location. (The authors state that in most cases seismic events can be located to an accuracy of 10-20 km. if data from ten well distributed stations are available. If calibration data from earlier events in the region are provided (as in the Threshold Test Ban Treaty) then the event can be located to within 5 km.).
   7) Problems and capabilities for depth estimation.
   8) Problems and capabilities for identification (which the authors claim is the main remaining problem in detection seismology) including a review of past monitoring experiments

(The authors conclude that identification methods can be applied with a high degree of confidence down to the detection threshold of magnitude 4, to distinguish earthquakes and explosions. There might however be a few, mostly low-magnitude, earthquakes which could not be confidently identified using seismological data alone).

9) Problems and capabilities for yield estimation.
10) Peaceful Nuclear Explosions - their possible applications, past tests, and future prospects
11) Review and evaluation of evasion methods including decoupling, multiple explosions and hide-in-earthquake methods (Of these the authors conclude that the most feasible is decoupling but only for low yield tests (assuming only seismic verification). Another limiting factor on decoupling is that it can only be employed in certain geologic areas which could be monitored by seismic networks).
12) Review of non-seismological verification methods including on-site inspection, reconnaissance satellites and intelligence methods, with an evaluation of their potential usefulness in a CTB.
13) Discussion of technical verification capabilities in relation to political requirements together with an outline of an operative monitoring system which would provide adequate verification of a CTB.

"Black boxes":

The advantage to the use of unmanned seismic stations capable of transmitting data to locations outside the host country is that by operating close to seismic events they could increase detection capability. They suffer from the political disadvantage arising from the fact that one country is establishing monitoring equipment in another. Another problem is to ensure that the stations will not be disturbed either by tampering with the station equipment or by artificial seismic disturbance created outside the station. The latter possibility, in the authors' opinion, is particularly important.

Peaceful Nuclear Explosions:

To monitor PNE's so as to ensure that no military advantages are acquired, it would be necessary to combine on-site inspection with provision (well in advance of the explosion) of data concerning yield, type and amount of fissile materials, and other matters. Visual inspection might be able to verify that chemical and not nuclear explosives were used in the case of large chemical explosions. For PNEs, analysis of radioactive products obtained at the explosion site would provide the possibility for confirming whether the explosion was conducted in accordance with the given specifications. Such radiochemical analysis could be carried out by an international agency or by national laboratories on radioactive samples obtained under appropriate international control.

Non-Seismological Identification:

The authors contend that on-site inspection and satellite reconnaissance must be regarded as complements to seismological monitoring. They cannot detect new explosions, but rather can only help identify events already detected and located by seismological means. It is difficult for the authors to understand why on-site inspection has been regarded by some states as a necessary verification method for a CTB. On-site inspections cannot increase the detection capability of the verification system nor counter possible evasion techniques since the idea behind such methods is that the illicit test would go undetected. Visual inspection could be useful for identifying earthquakes either by observing the effect on the environment or, especially, the lack of human activity in the area that would have been necessary if a nuclear test had been conducted. However, lack of human activity could also be verified by satellites. Only in relation to PNEs would on-site inspections be essential.

Because of the magnitude of effort required to cover large areas with high resolution satellite sensors continuous monitoring of whole countries seems unrealistic. Instead, satellite data would be used to supplement seismic data when an event was detected and located seismologically but not identified. The precautions needed to avoid such satellite reconnaissance would greatly complicate the violator's task. However, such satellite verification is applicable only to areas where there is no legitimate mining activity. Also reconnaissance satellites technology is today available only to a few states. If this method is included for monitoring a CTB then the satellite data must be made generally and easily available either directly or through an international data center.

Technical and non-technical intelligence methods could also be employed to monitor a CTB but because of the secrecy surrounding such methods it is not possible to estimate the kind or amount of information that can be achieved by such methods. The authors mention in particular the monitoring of communications in a state. Generally, the efficiency of intelligence methods does not depend on the yield of the tested explosion, but rather on the overall size and structure of the operation.

One other non-seismological verification method is monitoring of the mass media as well as public debate in a country. This could help is assessing particular events (eg. earthquakes) and general public reactions to certain proposals (eg. for a PNE).

A Monitoring System:

The authors propose a system for monitoring a CTB which, apart from being more scientifically detailed, is essentially the same as that suggested by Sweden in CCD/482* (26 March 1976). For the authors, the military significance of any nuclear test increases with the yield of the explosion and explosions below 1 kt have little military significance. The current detection

* See abstract I27(G76).

I29(A77)
I30(G77)

limit of seismic verification is about magnitude 4 or a 1 kt explosion in hard rock. Their system is designed to provide this detection capability.

PROPOSAL ABSTRACT I30(G77)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Japan. "Working paper on seismic array stations". CCD/524, 24 February 1977.
   See also: - PV. 733, 3 March 1977; and
   - "Working paper on focal depth resolvability of a multi-array stations system". CCD/540, 3 August 1977.

4. Summary:

The paper is a technical discussion of location capability of a multi-array seismic station network. It concludes that it would be possible to locate and even verify small yield blasts (i.e. 20-30 kt) using the existing seismic network if a better data exchange system could be arranged between an appropriate number of array stations.

It might be possible to use an existing data exchange system (such as the World Meteorological Organization) to connect the main array stations. Experimental work on location could be undertaken using such a network.

PROPOSAL ABSTRACT I31(G77)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - peaceful nuclear explosions

2. Verification Type:
   a) Seismic sensors (Article 4(1))
   b) On-site inspection - selective
   - non-obligatory (Article 4(2b))
   c) International exchange of information (Article 4(1))
   d) Complaints procedure - consultation and cooperation Article 4(2))
   - consultative commission (Article 3(2))
   - referral to Security Council (Article 4(3))
   e) International control organization
   f) Review conference (Article 6)

3. Source:
   Sweden. "Draft treaty banning nuclear weapons test explosions in all environments". CCD/526, 1 March 1977, and CCD/526/Rev. 1, 5 July 1977.*
   See also: PV./750, 5 July 1977.

4. Summary:
   The treaty is intended to establish a comprehensive test ban. Article 1(4) provides for a special transitional arrangement allowing the USA and USSR to continue conducting tests until all nuclear weapons states have ratified the treaty. Peaceful nuclear explosions would also be banned unless conducted under international supervision in a manner to be defined in an attached protocol (Article 2).

   The main verification and control provisions are found in Articles 3 and 4. The provisions are very similar to those in the Swedish 1969 draft treaty**, including the reliance on seismic monitoring and international exchange of seismic data, and the possibility of a non-obligatory form of inspection. A new element has been added, however, with the provision in paragraph 4 for the use of a Consultative Committee to ensure observance of the treaty. The functions and rules of this body are to be inserted into a protocol.

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* The organization of the articles of the drafts differs between CCD/526 and its revision. The numbers referred to here are taken from the revised draft.

** See ENDC/242, abstract I9(G69).

In PV. 750 Sweden makes it clear that the final assessment of data received from the seismic data exchange system would be made by the individual parties to the treaty not by any international body. However, the services of one or more data centres would be required to facilitate the interpretation of the data, especially for small countries.

Sweden also rejects the necessity for on-site inspection since it would not increase the deterrent to prospective violators nor avoid false alarms. Seismic monitoring alone is sufficient to achieve these objectives. On-site inspection would be useful only on rare occasions, in the form of an invitation by the host country to inspect.

PROPOSAL ABSTRACT I32(G77)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information
   c) On-site inspection - selective
   d) International control organization
   e) Remote sensors - satellite

3. Source:
   Japan. CCD/PV. 733, 3 March 1977.
   See also: - CCD/PV. 776, 2 March 1978.
   - CD/PV. 16, 6 March 1979.

4. Summary:

Since national means of verifying a CTB Treaty are insufficient, Japan proposes the creation of international machinery to: (1) speedily collect and analyze seismic data, and (2) conduct on-site inspection. Such machinery would consist of a committee of experts from both nuclear weapon states and non-nuclear weapon states. Though the main function of the body would be to receive and analyze seismic reports, it would also be empowered to ask for additional information and to recommend on-site inspection.

In CD/PV. 16 Japan states that on-site inspections are necessary to supplement any seismological methods of verification. However, if detailed arrangements for seismological verification by national means are reached, then the need for on-site inspection will be reduced so that a method like "verification by challenge" might be considered.

The committee of experts proposed by Japan in 1977 might also be given responsibility for advising on scientific and technical questions relating to verification, including the international seismic data exchange system.

Japan also contends in CD/PV. 16 that the verification system for a CTBT would be strengthened if agreement was reached on the setting up, on a reciprocal basis, of appropriate numbers of tamper-proof "black box" automatic seismic stations, as well as on observation by satellite.

PROPOSAL ABSTRACT I33(A78)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors - satellites

3. Source:
   Stockholm International Peace Research Institute. Yearbook of Armaments and Disarmament: 1978. London: Taylor and Francis, 1978, pp. 333-353.

4. Summary:

Substantial venting of radioactivity from underground nuclear explosions can be detected using available instruments. In addition, satellite observation can be used to obtain evidence regarding underground tests such as test site preparations, subsidence craters and dust clouds. However, while such non-seismic methods taken together represent a substantial verification capability, they are not effective in every case and therefore ultimate reliance must be placed on seismic monitoring.

The difficulties of seismic monitoring are outlined by SIPRI, as well as the current technological state of the art including networks, instrumentation, unattended seismological observatories and identification techniques. The threshold for identifying seismic events varies with the region, the stations providing the data and the distance from the event of the stations. Currently, it is about magnitude 4.0 or the equivalent of 1 kt in hard rock according to SIPRI. Problems of evasion arising out of decoupling, masking tests in natural earthquakes and earthquake simulation are also addressed. SIPRI concludes that any attempt at evasion would involve a balance of risks, costs and incentives. Since the military incentives for evasion are not large, it is difficult to see why evasions would occur.

PROPOSAL ABSTRACT 134(178)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Ad Hoc Group of Scientific Experts. "Report to the CCD of the ad hoc group of scientific experts to consider international cooperative measures to detect and identify seismic events". CCD/558, 14 March 1978.

4. Summary:*

The report is based on a consensus of the experts of the CCD working group. It describes how seismological science can be applied in a cooperative international effort to verify a CTB treaty. The cooperative international effort would have three elements:

1) a systematic improvement of the observations reported from a network of more than fifty seismological observatories around the globe.
2) an international exchange of these data over the Global Telecommunications System of the World Meteorological Organization, and
3) processing of the data at special international data centres for the use of participant states.

After an introductory chapter, the report gives a brief historical review of earlier studies relevant to the detection and identification of seismic events, though no attempt is made to assess the results of these studies.

The next chapter discusses procedures for extracting and reporting data from individual stations. The recommended procedures include the following:

1) Data are to be reported in standard form at two levels:
   (a) Level 1: Routine reporting, with minimum delay, of basic parameters of detected seismic signals;
   (b) Level 2: Data transmitted in response to requests for additional information, mainly waveforms for events of particular interest.

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* The following abstract is based mainly on the summary given at beginning of the report (pp. iii-x).

2) In contrast to current seismological practice, increased emphasis is on parameters for identifying events.
3) Strict operational requirements are set forth as to scope, consistency, reliability and promptness in the reporting.

The procedures to be applied for detection, location and evaluation of magnitude and depth of seismic events would follow existing standard practices. The Ad Hoc Group considers it outside its mandate to recommend criteria for identification of seismic events.

Chapter 4 deals with the selection of seismograph stations for the network which should include around 50 observatories. Because it is not known which countries will make available stations, the Ad Hoc Group has chosen to present four possible networks.

Network I	is based on stations for which information was provided to the Ad Hoc Group.
Network II	includes at least one station from each CCD member operating seismograph facilities.
Network III	is selected from among all known existing or planned stations according to purely seismological criteria.
Network IV (SRO)	is similar to Network III, but each station is hypothetically equipped with high quality instrumentation.

The next chapter deals with the estimated capability of the specified global system. The networks have a significantly greater sensitivity in the northern than in the southern hemisphere. The report summarizes the networks' capabilities on contour maps. The results for the network with the highest capability (Network IV(SRO)) are:

1) network detection capability for P-waves: 90% chance of detection at a minimum of four stations of events of m_b 3.8-4.2 in the northern hemisphere and of m_b 4.0-4.6 in the southern hemisphere;
2) network location capability: for a surface event of m_b 5.0, a 95% chance of locating the epicenter by a minimum of four stations with an error not greater than 10-20 km in the northern hemisphere and 20-50 km in the southern hemisphere; and
3) network detection capability for surface waves: 90% chance of detecting at a minimum of four stations, events of M_s 3.0-3.4 in the northern hemisphere and of M_s 3.4-3.8 in the southern hemisphere.

The paper makes no attempt to assess individual identification parameters nor to incorporate probabilistic models for seismic identification.

The next chapter - chapter 6 - is concerned with data exchange. The Group recommends that:

1) For Level 1 data (basic signal parameters) use be made of the Global Telecommunication System (GTS) of the World Meteorological Organization (WMO) because of its global availability, proven operation and low cost.
2) For Level 2 data (requested waveforms) which are usually more voluminous and less urgently needed, digital communication via WMO GTS or telecopying might be used in lieu of mail services.

Time delays for Level 1 data should be a maximum of 3-5 days whereas for Level 2 data a maximum of 4-6 weeks would be reasonable. The use of the GTS for transmission of seismic data has already been authorized by the WMO. The Ad Hoc Group believes that the excess capacity of the GTS is sufficiently large to accommodate the expected load of the proposed data exchange.

Chapter 7 deals with the international centres for collection, processing and exchange of seismic data. More than one centre should be created so as to achieve acceptable reliability. For technical reasons related to the GTS it would be desirable to place the International Data Centres in locations where main WMO communications centres are presently situated as well as in some other places (e.g. in the southern hemisphere).

The main tasks of the International Data Centres would be:

1) To receive Levels 1 and 2 data from seismic stations of the network via the authorized government facility of each state;
2) To apply agreed analysis procedures to the data for estimating origin time, location, magnitude and depth of seismic events;
3) To associate reported identification parameters with these events;
4) To distribute, in accordance with defined procedures and without interpretation of identification parameters, compilations of the complete results of these analyses; and
5) To act as an archive for reported data and results of the analysis of these data.

Chapter 8 deals with equipment and estimated costs of the proposed system. There are three major components:

1) Equipment for seismograph stations: The minimum equipment is already available at most of the stations con-

sidered. The desirable equipment would be modern, high-quality instrumentation which would ensure data acquisition in numerical form.
2) Data communications equipment.
3) The international data centre's modern medium size computer facility.

Detailed costs are not given because of great variations between countries but order of magnitude estimates are included in Table 8.2 of the report.

The concluding chapter contains a proposal for an experimental exercise. The experiment is needed to:
1) test the overall functioning of the new system.
2) determine its operational efficiency and deficiencies,
3) test telecommunications and data exchange procedures, and
4) obtain practical experience and thereby shorten the lead time necessary to implement the system.

The Ad Hoc group believes that at least six months will be needed to plan the experiment and an additional one year period will be required to execute and evaluate.

5. Selected Comments of States:

A number of countries supported the idea of the proposed experimental testing of the network. These included Sweden (CCD/PV. 779, 14 March 1978), the USA (CCD/PV. 779), Japan (CCD/PV. 781, 21 March 1978), Canada (CCD/PV. 781), the UK (CCD/PV. 780, 16 March 1978), the Federal Republic of Germany (CCD/PV. 802, 27 August 1978), Australia (CD/PV. 2, 24 January 1979), the Netherlands (CD/PV. 16, 6 March 1979), Italy (CD/PV. 18, 13 March 1979) and Belgium (CD/PV. 18, 13 March 1979).

The USSR (CCD/PV. 780, 16 March 1976) while accepting in principle the desirability of the experimental exercise contended that such an experiment could be carried out only after the conclusion of a CTB treaty when it will be known which states would be parties to the agreement. This was necessary since only then could it be determined which countries will decide on the experiment and contribute their seismographic stations to the network. Hungary (CD/PV. 17, 8 March 1979) took a similar position.

Japan (CCD/PV. 781) pointed out that the USSR's position would delay the carrying out of the experiemnt and the creation of the monitoring network. As a result, a CTB treaty would not be monitored for at least one year after it was signed since it will take at least that long to set up and conduct the test experiment.

PROPOSAL ABSTRACT I35(I79)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic sensors
   b) International exchange of information

3. Source:
   Ad Hoc Group of Scientific Experts. "Second report of the ad hoc group of scientific experts to consider international cooperative measures to detect and identify seismic events". CD/43, 25 July 1979.

4. Summary:*

The second report of the Ad Hoc Group deals mainly with technical and operational specifications for the data exchange network proposed in the first report.**

After reviewing its terms of reference and program of work the report deals in Chapter 3 with the specifications for Level 1 data (i.e. data which will be routinely exchanged). While the seismograph stations to be included in the proposed network do not presently have standardized equipment, only minor alterations are likely to be needed. The Group does recommend however that it is desirable for all network stations to be equipped with modern seismograph systems capable of continuous digital data recording. Operational procedures at network stations are not identical, but the Group recommends that existing practices continue to be used. Scope and consistency of reporting as well as equipment reliability and precision of calibration measurements will require more stringent standardization.

The parameters that are to constitute Level 1 data are given in the report as well as detailed instructions for their measurement. Because there is a lack of standardized procedures for automated measurements, manual measurement should continue to be used.

All seismic events registered by a station should be reported in terms of Level 1 parameters. An abbreviated form of reporting would be acceptable for events classified by a station's analyst as local earthquakes, quarry blasts or events belonging to a known earthquake sequence. Complete Level 1 data for these events would be furnished upon request.

Chapter 4 covers the data format and procedures for transmitting Level 1 data. The Group urges that the International Seismic Code

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* The following abstract is based primarily on the summaries given at the beginning of each chapter of the report.

**See abstract I34(I78).

be used as the basic format, together with some minor extensions. To ensure transmission reliability on the World Meterological Organization's Global Telecommunications System (GTS) formal arrangements must be made. Few problems are expected for transmitting Level 1 data on the high-speed circuits of the GTS but some difficulties are foreseen on peak load days on certain low-speed circuits (mainly in some regions of the Less Developed World). There is a need for further study of these problems.

The format and procedures for exchange of Level 2 data (i.e. waveforms) are discussed in Chapter E. Several transmission formats are possible including facsimile transmission, numeric transmission and air mail delivery. All these approaches should be tested in the proposed experimental exercise of the network. Careful study of the use of the GTS for transmitting Level 2 data is required since its present capacity to handle this data is limited. The chapter and its corresponding Appendix specify details which must be provided when requesting Level 2 data as well as suggested data recording media and formats.

In chapter 6 procedures to be used for data analysis at the International Data Centers are outlined. Data analysis should be performed using well-defined, automatic procedures though occasional interaction by a seismologist would be allowable if properly indicated on the results. Detailed technical procedures for seismic phase association, event location, depth estimation and magnitude determination are described in Appendices to this chapter. While identification data would be compiled and associated with the appropriate event, the Centers would not make any assessments as to the nature of any event.

Results of analysis should be reported via the GTS possibly supplemented by bilateral or multilateral arrangements between states. Preliminary bulletins would be distributed as soon as data allowed an event to be located. Detailed results should follow within a week of the event occurrence.

Each Data Center would have a data bank whose file structures and expected data volume are specified in Appendices to the report. These files would be stored permanently and the contents would be checked against files in other Centres. The Data Centres would normally conduct their tasks independently of one another but some coordination is necessary. There is a need for further research on the procedures to be employed in the Centres.

In the final chapter the Group makes several recommendations relating to a new mandate for itself and to promotion of national investigations concerning the proposed network.

5. Selected Comments of States:

India (CD/PV.47, 2 August 1979) raises questions concerning who will bear the financial burden of standardized equipment for the network stations and the cost of the Data Centres. In a similar vein, Australia (CD/PV.54, 5 February 1980, CD/PV.80 and CD/95 both 22 April 1980) outlines several matters at which it feels the CD should direct its attention. Consideration of these matters now would avoid delay in the conclusion of a multilateral treaty and creation of an institutional framework for an international seismic detection network. This position was supported by Canada (PV.89, 3 July 1980). Among the subjects suggested bv Australia for consideration are:

a) The legal basis for the international seismic network:
   eg. - the need for a separate legal umbrella for administrative, financial and other matters;
   - what will be the relationship with other international bodies?

b) Administrative and financial aspects:
   eg. - the need for an administrative secretariat and its functions, site, staffing and financing;
   - details regarding data centres and seismic stations;
   - national versus multilateral staffing and financing responsibilities.

c) Access and information distribution:
   eg. - will non-parties, international organizations and scientific institutions have access?

d) Role of the UN in the institutional arrangements.

e) Communications links with WHO.

PROPOSAL ABSTRACT I36(G79)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) Seismic Sensors
   b) International exchange of information

3. Source:
   Sweden. "Working paper on International Seismic Datacenter Demonstration Facilities in Sweden". CD/45, 30 July 1979.
   See also: Sweden CD/PV.46, 31 July 1979.

4. Summary:
   This paper gives a description of temporary international seismological datacenter facilities currently operating in Sweden plus an overview of the results from a recent test conducted using those facilities. In PV.46, the Swedish delegate points out that the International Datacentres (for which the Swedish temporary facilities are intended as a model) suggested by the Ad Hoc Group of Scientists* as part of a global seismic monitoring network, will permit all states to base their national assessment of individual seismic events on data from the entire globe. In this way small states will also be able to verify the test ban in a meaningful way.

   The working paper begins by outlining the tasks of such a datacentre:

   a) receiving and storing Level 1 data transmitted through the World Meteorological Organization's Global Telecommunications System (GTS),
   b) combining data with the appropriate event,
   c) compiling reported identification data,
   d) providing analysis of Level 1 data to the parties within a week of the occurrence of the event,
   e) storing the results of the analyses,
   f) playing a role in the exchange of Level 2 data, and
   g) providing other service functions in connection with test ban verification.

   For coordinating the efforts of the Centers and ensuring proper execution of their functions, the service of an appropriate international body might be needed. This body would also review new developments in the field.

   The Swedish demonstration included three elements. First there was a temporary computer connexion to the GTS. During the demonstration seismic data was transmitted from several countries and received in Sweden.

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* See abstract I34(I78).

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The second element comprised several computer programs compiled for the analysis and handling of Level 1 data. A problem with these programs is that they sometimes result in the generation of spurious events. Fully automatic processing using the programs, however, would permit the production of identical output bulletins. More research is being conducted in this area.

The demonstration facilities were tested using an experimental database based on data from 60 seismological stations over the period of one week. This database constituted the third element of the Swedish demonstration.

On the basis of the test some useful insights were gained. For Level 1 data there is considerable difference between seismic data routinely reported at present and that necessary for test ban verification. It is important that procedures be developed at individual stations to extract and report those additional data needed for test ban verification. This, however, could be quite extensive and tedious work. Some of the seismic data which was suggested by the Ad Hoc Group in their report turned out not to be very useful and its inclusion should be reconsidered. Information on downtimes of individual stations and of their detection capability or actual noise values proved to be of great importance for the analysis of data.

The 60 station network from which the test data was compiled was quite efficient in defining and locating seismic events which supports the conclusion of the Ad Hoc Group that a network of 50 to 60 globally distributed stations will be satisfactory for verification.

Test evidence suggests that datacenters would substantially improve their ability to associate short period signals and to define new events if preliminary location data were reported from the individual stations in the global monitoring network. Results suggest also that routine analysis and reporting of long period surface waves is valuable and that short period identification data can be compiled without assessing the nature of the event.

Regarding data handling routines, the Swedes found that database systems were inferior to specialized routines for data handling, storage and retrieval.

No specific technical problems were encountered regarding the use of the GTS. However, because seismic data is still unfamiliar to GTS operators, tests should be conducted to familiarize them with it.

The compilation of complete records of both short and long period (Level 2) data showed the value of having the full records obtained by individual stations available when assessing and interpreting a seismic event. Consequently, efficient routines for the exchange and compilation of Level 2 data should be established.

The Swedish paper concludes by indicating that the research at these temporary datacenter facilities will continue.

PROPOSAL ABSTRACT I37(G79)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - peaceful nuclear explosions

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors
   c) International exchange of information
   d) On-site inspection - selective
   e) International control organization
   f) Complaints procedure - consultation and cooperation
   g) Review conference

3. Source:
   United Kingdom. CD/PV.46, 31 July 1979.
   See also: - UK/USA/USSR. CD/130, 30 July 1980.
   - UK. CCD/PV. 780, 16 March 1978.
   - UK. CCD/PV. 798, 8 August 1978.

4. Summary:

In a statement on behalf of the UK, USA and USSR in PV.46 regarding the progress of the tripartite negotiations on a treaty prohibiting nuclear weapon tests in all environments and its protocol covering peaceful nuclear explosions, the UK delegate noted that agreement had been reached on several points:

a) The treaty should provide for verification by national technical means and for the possibility of on-site inspection.
b) An exchange of seismic data is an important aspect of verification. In this context the Ad Hoc Group of Seismic Experts' recommendations* will influence the way in which the exchange of seismic data is implemented in practice.
c) A Committee of Experts drawn from the parties to the treaty should be established to assist in the implementation of the exchange.
d) After a certain period, there should be a conference of the parties to review the treaty's operation.

A more detailed review of the tripartite talks' progress was presented in a joint working paper in July 1980. Regarding verification the parties have agreed that:

a) National technical means of verification will be employed in a manner consistent with generally recognized principles of international law. Parties will undertake not to interfere with NTMs.
b) An International Exchange of Seismic Data will be established. Parties will have the right to participate in this exchange, to

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* See abstract I34(I78).

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contribute data, and to receive data. The data will be transmitted through the Global Telecommunications System of the World Meterological Organization. International seismic data centres will be established at agreed locations.

c) A Committee of Experts will be established to consider questions related to the Data Exchange, to which parties can appoint representatives. This body will have its first meeting within 90 days of the entry into force of the treaty.
   i) This Committee will elaborate arrangements for the Data Exchange including technical standards for participating seismic stations and data centres, form of data to be received from stations, and form of data to be made available by the data centres.
   ii) The Committee will also have ongoing responsibility for facilitating the implementation of the Data Exchange, for reviewing its operation and possible improvements and for considering technological developments affecting its operation.

d) The treaty will include a provision for direct consultations and exchanges of inquiries and responses between the parties. A party may request an on-site inspection in the territory of another giving reasons for its request including appropriate evidence. The party receiving the request shall state whether or not it will agree to an inspection giving reasons for any refusal.

e) There will be provisions for permitting two or more parties, because of special concerns or circumstances, to agree upon additional verification measures. The three negotiating parties have agreed that such additional measures are necessary for themselves. Such measures, while paralleling those of the treaty itself, will specify in greater detail the procedures for on-site inspection, giving a list of rights and functions of the inspectors as well as detailing the role of the host government. In addition, the three parties are negotiating an exchange of supplemental seismic data involving the installation and use of high-quality seismic stations of agreed characteristics.

f) There will be a review conference provision. Amendments to the treaty will require consent of the permanent members of the Security Council which are parties.

5. Selected Comments by States:

Several delegations were concerned about the timing of the establishment of the Committee of Experts. The Netherlands suggested that a provisional committee be set before the coming into force of the treaty, which would prevent delay in setting up the Data Exchange system (CD/PV.97, 5 August 1980). Sweden suggested such a role for the *Ad Hoc* Committee of Seismic Experts (PV.97). See also: Australia

(PV.97) and Japan (PV.98, 7 August 1980).

The Netherlands (PV.97) also pointed to the need for a more general political "consultative committee". Canada (PV.99, 8 August 1980) shared this view. There was also concern expressed over the provision for a special, independent verification system limited to the three negotiating parties. See: Pakistan (PV.97), India (PV.97), and Sweden (PV.97).

The Netherlands (PV.97) and Canada (PV.99) favoured a "liberal policy" regarding the seismic network whereby non-parties to the Treaty could provide data to the network and receive data from it.

PROPOSAL ABSTRACT I38(I80)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - partial test ban

2. Verification Type:
   a) Seismic sensors
   b) On-site inspection - selective
   c) Remote sensors - satellite
   - ELINT
   d) Short-range sensors - monitoring devices

3. Source:
   United Nations. Secretary General. "Comprehensive Nuclear Test Ban: Report of the Secretary General". CD/86, 16 April 1980.

4. Summary:

This report includes an historical review of negotiations related to a comprehensive nuclear test ban for the period from 1955 to 1979. Verification is identified in the report as one of the major issues still unresolved. The report points out that the problems of verifying a CTB differs in important respects from those of the Partial Test-Ban Treaty of 1963* since clandestine underground nuclear tests under a CTB could provide a military advantage to a violator. The alternative of a threshold test ban poses even more verification problems than a CTB.

It is generally recognized that seismological means are a most effective form of verification and can deter violations. This method will constitute the principal component of a global control system for an underground test ban. After reviewing the reports of the Ad Hoc Group of Seismic experts** and the progress of the tripartite talks on the CTB in 1979, the report refers to the supplemental verification arrangements planned by the UK, USA and USSR for themselves as part of the envisaged CTB. These arrangements would apparently consist of the national seismic stations (advanced, tamper-proof stations, nationally manned, as opposed to automatic black boxes). Data from these stations would be continuously and directly transmitted outside the host country. Such stations would help lower the detection threshold and if properly distributed could provide supplementary identification data. In addition, they could serve to deter evasion if placed where geological structures might be considered suitable for clandestine tests.

On-site inspection has been urged because there may remain a few events of uncertain origin each year despite a global seismic

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* See abstract H4(T63).
**See: abstracts I34(I78) and I35(I79).

monitoring network. If the global seismic network is supplemented by national seismic stations, satellite observations and electronic intelligence gathering, the need for on-site inspections should be further reduced.

Questions will arise regarding application of the whole verification system if some verification arrangements are reserved solely for the UK, USA and USSR, especially if China and France decide to particpate in the CTB. The report raises several questions concerning these special arrangements. Will other states be required to set up national seismic stations? Will data from such stations be generally available? Will on-site inspections on the territories of the three powers be conducted with the participation of other states as well? Also, what will be the relationship between the special arrangements for the three powers and the general verification system for all the parties?

The Secretary General's report concludes with the assertion that "verification of compliance no longer seems to be an obstacle to reaching agreement".

5. Selected Comments of States:

The US representative (PV.97, 5 August 1980) rejected the conclusion of the Secretary General's report that verification was no longer an obstacle. He pointed to a paragraph in the report by the three CTB negotiating parties* which stated that verification provisions must first be agreed in principle and then worked out in detail, a laborious process. It must be done with care because implementation of these measures will have an important impact not only on ensuring compliance, but also on political relations among the parties.

* CD/130, 30 July 1980; see abstract [illegible].

PROPOSAL ABSTRACT I39(A81)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban
   - partial test ban

2. Verification Type:
   a) Seismic sensors
   b) Remote sensors
   c) On-site inspection - selection
   d) Short-range sensors - monitoring devices

3. Source:
   Hussain, Farooq. The Future of Arms Control: Part IV, The Impact of Weapons Test Restrictions. Adelphi Papers #165. London: International Institute of Strategic Studies, 1981.

4. Source:

The author provides a concise review of current capabilities for remote monitoring of nuclear tests. Regarding underground tests he assesses the current seismic detection threshold to be about 1.5 kt for explosions in hard rock and the identification threshold to be between 5 and 10 kt. Methods of evading seismic detection are discussed including past tests on the feasibility of some of these techniques. Of these evasion methods decoupling is the easiest. It could be thwarted, however, by the use of remote seismic monitoring stations located at selected sites in the US and USSR and by permitting on-site inspection by challenge. With regard to the remote monitoring stations, problems may arise because these devices have not yet been fully tested. Also, becuase these stations could be inspected by nationals of the countries in which they are located, it may be possible for violators to gauge the detection threshold of the system and thus facilitate evasion.

Many of the limitations on verifying a comprehensive test ban also apply to monitoring a partial test ban such as the Threshold Test Ban Treaty of 1974, some of the verification problems of which are discussed. Hussain concludes that it should be possible to verify within tolerable limits an agreement to restrict both the number and yield of nuclear weapons tests (to roughly six per year at yields of 5 to 10 kt). He believes, however, that a CTB Treaty would have little value as a means of restraining further nuclear weapons innovation since the options for significant new developments are virtually exhausted.

Regarding atmospheric tests, Hussain points to the suspected nuclear test in the South Atlantic of 22 September 1979 as indicating that even with modern surveillance satellites violations of the PTBT are still feasible. He also discusses concerns about nuclear testing in the upper atmosphere and outer space. Since all spacecraft are tracked and identified, the chances of such tests successfully evading detection are reduced.

CHAPTER J

LITERATURE SURVEY

Literature surveillance involves the monitoring of openly available sources of information, especially scientific publications, news media, and governmental statements and publications. The technique is closely related to records monitoring and international exchange of information. In its widest meaning, it is applicable to the verification of a wide range of arms control commitments though the term has recently become identified with the monitoring of scientific literature in the context of a treaty banning chemical and biological weapons.

The technique in its broadest sense is a significant element of any national capability to verify compliance with an arms control undertaking. It is certain that many national intelligence gathering and diplomatic services employ some form of literature survey. However, it is very doubtful whether this technique alone can provide sufficient assurance of detecting violations to satisfy many states. Problems include insuring credibility of the information found in open sources and properly interpreting the data acquired. Costs related to the technique do not seem exorbitant especially when it is realized that extensive systems of literature surveillance already exist in one form or another.

One query about the approach is whether information which might indicate a violation would ever be openly published. This is a particularly serious question in regard to those nations which exercise tight controls on what is published. It is also possible that false information could be issued in order to mislead a verification body.

Budgetary Analysis

Budgetary analysis can be described as a special form of literature surveillance though proposals using this approach frequently incorporate the use of other verification techniques to overcome the short-comings of relying on openly published budget information. Suggested applications include monitoring commitments in the CBW field and general disarmament undertakings. With regard to the latter, the League of Nations studied the approach before World War II. More recently, the UN Secretary General has considered it in relation to a suggested agreement on restricting military budgets. Unfortunately, there are a number of problems with the use of budgetary analysis. Much budgetary decision-making and accounting activity, particularly that related to military expenditures, has never been openly reported. In other cases, quite the opposite may be true: there may be such an abundance of confusing information that much effort is entailed in sorting out the real picture.

Lack of any commonly agreed procedures for classifying and reporting financial information is another difficulty. Governments may categorize expenditures and receipts differently because of legitimate differences of opinion. To be of much value, a verification system based on budgetary analysis would probably require standardized and open budgetary reporting procedures in all states. This would be an extremely difficult task to accomplish.

In conclusion, it is clearly improbable that either literature surveillance in general or budgetary analysis in particular can at present serve as the primary element in a verification system. At best they might have limited value when used in conjunction with more technically efficient techniques or in the case of budgetary analysis when supplemented by more intrusive methods.

Contents of Chapter J:

Arms Control Objective	Number of Proposal Abstracts
Chemical weapons	2
Military budgets	4
General and complete disarmament	1
Any arms control agreement	1
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PROPOSAL ABSTRACT J1(G73)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) Literature survey
   b) Remote sensors - satellites
   c) Records monitoring - economic
   d) Complaints procedure
   e) International control organization

3. Source:
   Sweden. "Working paper on the concept of amplified verification in relation to the prohibition of chemical weapons". CCD/395, 6 March 1973.
   See also: - CCD/PV. 590, 8 March 1973;
   - CCD/PV. 610, 5 July 1973; and
   - CCD/PV. 622, 16 August 1973.

4. Summary:

The paper envisages the use of a number of independent verification methods each of which individually is of limited efficiency in detecting a violation. Each, however, could detect with a known efficiency, changes in normal activities in the chemical field. The cumulative effect of such indications of change would be to trigger further inquiries directed at the suspect party. The occurrence of many warning signs together with an unwillingness to explain them on the part of the suspected party, or to let an investigation take place would consititute grounds for the complainant to withdraw from the treaty. The problem of a high rate of false alarms would be overcome if each party viewed the alarms not as an accusation of a violation but rather as a warning sign which initiates further inquiry and as such is merely a routine matter.

It is assumed that the control methods and investigations would be managed by an international agency. It is also assumed that any violation would necessarily involve a number of different activities detectable by different methods of cerification.

Sweden includes in the paper a table giving "hypothetical values of revealing probabilities" for a variety of verification techniques. The paper is unclear as to how these estimates were derived.

The paper claims to emphasize "reassurance" rather than "deterrence". Some states find it unacceptable to run the risk of being falsely accused of a violation; therefore the system is not designed to catch a violator red-handed but merely to monitor normal activities relevant to a CW capability. Deterrence, in fact, is unnecessary provided other states receive adequate warning of any violation so that they can prepare defences.

The mechanism envisaged in this paper could be independent of other control mechanisms such as referral of complaints to the UN or verification by invitation.

In PV. 622 Sweden, responding to American criticism of the paper, suggests that it is not deterrence that is the primary object of verification but rather confidence building (i.e. "reassurance"). The paper does not say that deterrence is unimportant, only that reassurance m come first.

Sweden also believes that the use of estimates of the detection probability for the various verification methods suggested (i.e. the "hypothetical values of revealing probabilities"), are not meaningless as the USA contends. They are "judgemental probabilities" not of the detection of violation itself, but of deviations from normal activities resulting from the violation.

Sweden also emphasizes that any violation would involve a multiplicity of activities on the part of the violator. A "one activity" violation is the most difficult to detect but, while such a violation is possible, it is a worst case example not applicable to most states.

In PV. 610 Sweden claims that the concept of amplified verification is applicable beyond the CW disarmament field.

5. Selected Comments of States:

The USA criticized the Swedish proposal on a number of grounds*. While the USA agreed with the basic idea that verification is enhanced to some extent if a range of activities is monitored by various means, it contended that there are, nevertheless, a number of problems with the Swedish concept of "amplified verification". First, the "hypothetical values of revealing probabilities" suggested in the paper for a number of verification techniques are purely hypothetical since there is no evidence to back up the estimates.

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* See CCD/PV. 618, 2 August 1972.

Second, the concept of "amplified verification" is based on the idea that a violator will be engaged in a number of activities to create the CW capability. This is not necessarily so; a violator may deliberately limit himself to one or two activities. The probability of detection is, furthermore, related to the scale of these activities. There may be no "amplified verification" resulting from the cumulative possibilities of detection when only one or a few activities are involved.

Third, should "amplified verification" not work, a country could find itself at a significant military disadvantage as a result of a violation which it could not rectify quickly by creating its own CW cabability.

Fourth, the odds of detection by various means can be significantly affected by the unpredictable and unknown steps that a violator may take to evade detection.

Fifth, one cannot count on several warning signs occuring simultaneously given the violator's ability to manage and time a violation. Thus, the right of withdrawal cannot be exercised by a party suspicious of a violation without incurring the political onus of having destroyed the treaty.

Sixth, the US objects to the paper's emphasis on "reassurance" rather than "deterrence". It is impossible to distinguish between the two, since reassurance is based on confidence in the effective deterrent provided by verification systems.

PROPOSAL ABSTRACT J2(G78)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   Literature survey - sampling

3. Source:
   Sweden. "Working paper on a methodological investigation for computerized scanning of chemical literature". CCD/569, 24 April 1978.

4. Summary:

Manual scanning of relevant literature is time consuming since a large number of journals must be covered. However, there exist a large number of publications of abstracts which facilitate literature searches. Many of these abstract publications appear also on magnetic tape and can be scanned by computers. This paper is intended to investigate suitable methods for utilizing such databases and to evaluate their possible applicability in connection with a CW treaty.

A computerized literature search should ideally catch only relevant items. When comparing manual versus computerized searches, it must be observed that computerized retrieval is advantageous since many concepts (or keywords) can be watched whereas doing this manually would require much greater effort. An evaluation of the size and usefulness of different databases made it clear that the most comprehensive coverage will be obtained when several databases are searched simultaneously.

The study reported in this working paper focussed on the computer readable version of Chemical Abstracts. (This publication in 1977 contained references to approximately 410,000 papers and reports). The study consisted of two parts. First, a preparatory study was carried out on material from five issues of Chemical Abstracts within the field of biochemistry and organic chemistry (26,488 references). These references were manually searched and read by two experienced chemists. These chemists selected out the most interesting references which were then reclassified by a highly qualified scientist as to their "novelty" and "military" interest.

On the basis of this preparatory work, different search strategies were formulated and tested. The main study consisted of the application of selected strategies to twenty subsequent issues of Chemical Abstracts containing 128,740 references. The two chemists scanned the output from the computer and the scientist reclassified their selected references as in the preparatory study.

The results of this study show that it is possible to formulate effective search strategies for computerized searching of databased literature references in order to acquire information concerning CW agents. The method substantially diminishes the amount of work required for literature surveillance. It appears possible, on the basis of the results here, to reduce the database to 1-4% of its original size, while still retaining 63-69% of relevant references in the material. It seems possible to improve the method and also to apply it to other databases.

PROPOSAL ABSTRACT J3(A62)

1. Arms Control Problem:
   Military budgets

2. Verification Type:
   a) Literature survey - budgetary analysis
   b) International control organization

3. Source:
   Woods Hole Summer Study. Verification and Response in Disarmament Agreements. Annex Volume I. Washington, D.C.: Institute for Defence Analysis, 1962.

4. Summary:
   This proposal suggests that an international disarmament organization would have the right to audit national budgets in order to verify either the elimination or restriction of military budgets. Public disclosure of data would be limited to that connected with detected violations.

PROPOSAL ABSTRACT J4(I74)

1. Arms Control Problem:
   Military budgets

2. Verification Type:
   a) Literature survey - budgetary analysis
   b) International exchange of information
   c) Records monitoring - plant
   d) Remote sensors - satellites
   e) On-site inspection - selective

3. Source:
   United Nations. Secretary General. "Reduction of the military budgets of states permanent members of the Security Council by 10 per cent and utilization of part of the funds thus saved to provide assistance to developing countries", Document A 9770, 14 October 1974.*
   See also: -United Nations. Secretary General. "Measurement and international reporting of military expenditures: Report of the group of experts on reduction of military budgets", Document A/31/222 Rev. 1, 20 October 1976.
   -United Nations. Secretary General. "Reduction of military budgets", Document A/32/194, 14 September 1977.

4. Summary:
   The 1974 Report delves at some length into the difficulties of verification which it sees as a central problem to any agreement on the reduction of military budgets. Verification, as the Report defines it, involves a procedure for obtaining and evaluating information about changes in a party's military expenditure. The need for actual exchange of information is dependent on the degree of trust between the parties. But because of the impact on national security resulting from such budgetary limitations it is likely that states will demand a verification mechanism which will provide timely and incontestable evidence of violations.

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* An adaption of Annex II of this report was prepared for the US Arms Control and Disarmament Agent in 1976. See: Abraham S. Becker and Bengt-Christer Ysander, International Limitations of Military Expenditures: Issues and Problems. Santa Monica, California: Rand Corporation, April 1976, R-1911 ACDA. Also see Abraham S. Becker, Military Expenditure Limitation for Arms Control: Problems and Prospects: With a Documentary History of Recent Proposals. Cambridge, Mass.: Ballinger, 1977.

The type of information required is economic and financial, not numerical estimates of physical forces. The basis for providing this information would be a standardized method of budgetary reporting of military expenditures. The report deals with the problems and possibilities of developing such a method. The verification system likewise would be based on economic and financial data. Because the expenditure limitation would restrict the ability of a party to respond to a violation, more complete and accurate information would be demanded after the limitation was imposed than before, in order to ensure compliance.

The type of additional information demanded would vary with the nature of the agreement. Generally, to verify changes in military expenditure it is necessary to specify base levels of expenditure with confidence. Therefore, verification requires definition of and comparability of military expenditure, price indices and perhaps international purchasing power parities. Supporting data on financial and physical flows compiled at intermediate or even primary levels are also needed to check for evidence of evasion.

The report suggests that it would be helpful to provide information in the form of national income accounts, input-output tables, flow-of-funds accounts and manpower balances which would permit determination of the way in which the military sector fits into the economy of a state as a whole. This would make possible a number of cross-checks to ensure that the size and pattern of the military sector was correctly stated.

The report deals with a number of problems which will be faced by the verification system. To begin with, it points out two general methods of evasion which must be guarded against. These are, first, the artificial reduction of the prices at which military transactions are recorded and, second, the shift of some kinds of military expenditure to non-participating allies or to the civil sector in some way.

Another problem pointed out by the paper is a general one. Countries may differ as to the amount of information which they have published in the past concerning military expenditures Thus, there is a potential for some countries to gain more than might others from the additional information provided under the agreements.

A further serious problem is the intrusive nature of the verification system. It requires access to much information on force levels and expenditures which conflicts with the traditional interests of states in protecting the security of their military establishment. To avoid this problem indirect verification might be undertaken. This involves detecting physical observable elements of the military budget (e.g. forces, facilities, etc.) by satellites and then estimating the expenditures required to acquire these elements. While such an approach may work for some aspects of the military sector it does not for small weapons nor is it capable of dealing with qualitative factors. It also requires interpretation of the data on observables which introduces room for considerable estimate error. Use of supplementary economic information to help reduce possible errors would lead again to the problem of intrusiveness. Satellites also have the problem that they are available only to a limited number of states. To remedy this a joint or international satellite service might be envisaged.

The report goes on to discuss an "information - disclosure ladder" which might assist in building tolerance to increasing levels of intrusiveness. The lowest rung of this ladder would involve simple confidence building endeavors such as publication of military accounts in aggregated form plus explanatory material. Higher on the ladder there might be provision for price indices and price-cost information for estimation of purchasing power parities to facilitate international comparisons. Historical time series would assist in establishing baselines for measuring changes. Higher still there might be submission of national accounts, input-output tables, research and development, financing and support accounts. At the highest level, information is provided from intermediate and primary national production and distribution units and opportunity is afforded for non-nationals to audit unit records by on-site inspection.

The Group of Experts submitted a further Report in 1976, the purpose of which was to define "the major components of a system of military expenditure concepts, definitions and measurement procedures, along with a corresponding reporting structure". (p.4) The implementation of the international reporting system would, according to the report, constitute only the first step towards realization of expenditure limitations. Other technical issues especially that of verification remain to be resolved. The utilization of the reporting system would serve mainly a confidence building role. The report concludes by calling for tests to operationalize the reporting scheme.

A third report was issued by the Group of Experts in September 1977, which included the views of a number of states on the previous reports, together with comments by the Group of Experts on these replies. Concerning suggestions that some states are unable to provide the detail demanded by the reporting scheme, the report points out that any attempt to reduce the level of detail will complicate the task of verification. "The more detailed the data required, the easier it becomes to cross-check and verify" (p. 23).

Another way of reducing costs of reporting is to retain the level of detail but allow some approximations to be made for some of the entries in the reporting scheme's matrix. But again such an approach would reduce the reliability of the matrix since "the numerous links between the cell entries and financial and physical data beyond the boundaries of the matrix, together with the requirement for internal consistency, both of which give the completed matrix a broad range of verification possibilities, would be much less precise" (p.24). This loss would be reduced if countries reported in detail the procedure used to arrive at such approximations.

PROPOSAL ABSTRACT J5(A75)

1. Arms Control Problem:
   Military budgets

2. Verification Type:
   a) Literature survey - budgetary analysis
   b) International exchange of information

3. Source:
   Holzman, F.D. Financial Checks on Soviet Defence Expenditures. Lexington, Mass.: D.C. Heath & Co., 1975. Especially chapter 5, pp. 47-71.

4. Summary:

Before giving details of this verification proposal, it would be useful to review some of Holzman's general comments on verification and some other relevant matters he raises.

Holzman believes that financial verification in a centrally planned economy is possible. Despite "the fact that a major part of the resources of the Soviet economy are directly allocated by planners, the Soviet economy is nevertheless largely a money economy in which almost all commodity flows, including those connected with defence, are reflected in financial flows. This means that if the accounts are made available, financial checks of claimed reductions in military expenditures, should in principle be possible and adequate" (p.2). Indeed, since almost all economic activity in the USSR is nationalized and centrally planned, data on military expenditures should be more complete, more systematized, and more available to authorities than may be the case in the West. On the other hand, Holzman continues, the more complete state control suggests that manipulation of data designed to mislead would be easier.

The book describes at length the financial sources of Soviet military expenditures including explicit budgetary categories, other possible budgetary sources, and possible non-budgetory sources. It then deals with the verification question as it relates to these financial sources.

Budgetary expenditures: The essential requirement for verifying the Soviet budget would be the availability of broader and more detailed information with respect to both defence and non-defence categories. This data must be published by the Soviet Union as part of its regular annual budget. Publication is essential, the author claims, since the Soviets would be more inhibited from falsifying published data than if

they merely submitted the data to a verification organization.

In addition, the Soviets must publish similarly detailed budget accounts for the past 5 or 10 years. This would help ensure the reliability of the future budget information since the past budget data would:

1) Provide a rigid framework within which new data must fit;
2) Provide a basis for establishing a trend framework within which new data must fit; and
3) Enable the use of significance tests.

Holzman continues by elaborating on the use of trend analysis, pointing out some serious problems with it, including:

1. The approach assumes that trends are generated randomly;
2. Any deviation from the trend would have to be large to be detected; and
3. Most importantly, it would be difficult to distinguish between the hiding of clandestine military expenditures in "other" budget categories from the reasonable Soviet adjustment of these "other" categories when resources are released due to legitimate reduction in military expenditures. (That is, if the Soviets reduced their military expenditures by 15%, they would use the released resources elsewhere which would be recorded in the **budget as an increase in some category(s)**. It would be difficult to tell whether this increase was a clandestine military expense or a legitimate "other" expense.) The only way of overcoming this problem is to allow some rights of auditing concerning items where suspicion arose.

Finally, Holzman points out that as well as more detailed budgetary data, provision of non-budgetary data would help in verification since comparisons could be made between the two sets of information.

The Budget Surplus and Hidden Budget Expenditures: Again the essential requirement for successful verification is the provision of better information by the Soviet Union particularly on the disposition of the budget surplus. It would also be desirable to obtain the complete balance sheet from Gosband (i.e. the Soviet state bank) and to check the accuracy of the Gosband balance in a manner similar to that taken with the budget (i.e. trend analysis).

Separate Secret Accounts: Such accounts would be kept outside the budget. It would not be possible to detect them through examining the expenditure side of government finances; concentra-

J5(A75)

tion would have to be focussed onto the revenue side by reconstructing government receipts from a single source of revenue (e.g. the sales tax). If the hidden accounts derived from a number of revenue sources, the problem of detection would be much more difficult. To enable checking concerning separate accounts it is necessary that the Soviets publish greater detail about the revenue side of their budget, including historical data for trend analysis. Other problems concerning this method of checking separate accounts include:

1. The separate account would have to be large in order to be detected;
2. Certain sources of revenue do not have rate structures which would facilitate their reconstruction by the verifying body; and
3. The Soviets have a propensity for unconventional budgetary accounting which would complicate verification.

Bank Credit: To check on the possibility that clandestine military expenditures might be channeled through the banking system in the guise of extensions of credit, it would be necessary to use similar methods to those employed concerning budget expenditures (i.e. trend analysis).

Retained Profits, Amortization Funds and Other "Sources" of Expenditure: There is no very reliable method for verifying these. All methods depend on obtaining detailed accounting of such expenditures. Even if this information is provided problems would arise, such as that resulting from the "netting" of some profits.

Pricing Problems: The major problem in this regard is that reductions in military expenditures could be simulated by manipulating prices, either by reducing sales taxes or by increasing subsidies (especially the latter). Here again the key to verification is the provision of fuller budget information by the Soviets. Problems also arise in distinguishing legitimate changes in factor costs and disguised military expenditures.

The Financial Balance: The USSR compiles, but does not publish, a detailed economic balance of the national economy. Of particular relevance to verification are two elements of this - the Material Balance and the Financial Balance (especially the latter). It would be more difficult to falsify the Financial Balance than the budget because of the many interrelationships made explicit in the Balance, because the categories in the Balance are more functionally related to independent aspects of the economy which could be checked, and because falsifying the Balance would be more internally dysfunctional. However, the Financial Balance data would have to be provided by the Soviets, and in somewhat more detailed form, particularly concerning the military categories. Together with historical budget data and other data currently available, the Financial Balance could make verification much easier. However, "even with all these data, it would still undoubtedly be possible to hide military expenditure if the determination to do so were sufficiently great" (p.71).

J6(A75)

PROPOSAL ABSTRACT J6(A75)

1. Arms Control Problem:
   Military budgets

2. Verification Type:
   a) Literature survey - budgetary analysis
                        - sampling
   b) International exchange of information
   c) On-site inspection - selective
                         - sampling

3. Source:
   Holzman, F.D. Financial Checks on Soviet Defence Expenditures. Lexington, Mass.: D.C. Heath & Co., 1975. Chapter 6, pp. 73-83.

4. Summary:

There are problems with verification based on the acquisition of additional data concerning Soviet budgeting expenditures as outlined in Chapter 5 of Holzman's book*. The Soviets may simply be unwilling to provide additional information in the amounts necessary for verification. Furthermore, even if such additional information is forthcoming, there will remain serious problems in detecting clandestine military expenditures. Therefore, Holzman proposes an alternative verification method "which does not require the surrender of additional aggregative information, yet...which gives promise of providing as reliable a check on compliance...as may be obtained" (p.73). This method is based on the use of sampling techniques. It would be possible to use this method alone or as a complement to verification based on submission of additional data.

Budget Expenditures: Assuming that all military expenditures go through the budget, the "verification procedure envisaged is to run a sample check on all checks, vouchers and so forth made out in the Gosbank (i.e. the Soviet state bank) on the budget account. If the sample is random and the distribution "by size" of checks made out for defence is identical with the size distribution of nondefence checks, then a relatively small number of checks would need to be sampled to be able to determine, with a high degree of probability, the percentage that military expenditures are of the total budget expenditures" (p.74). Should the size distributions of defence and of nondefence checks be significantly different, then larger samples may be required or resort might be made to stratified samples.

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* See abstract J5(A75).

Generally, the size of the random sample would vary with the desired level of confidence and acceptable error. For example, a sample of 27,592 items would give a 99% confidence level that the sample differed no more than ½ % from the actual population.

The detection risk for a violator is generally high even with small samples. The risk, however, varies with the amount of cheating involved: the larger the violation the greater the chance of detection. With small violations more care would have to be taken concerning acceptable error factors and therefore larger samples might be required.

The proportion of defence expenditures to total expenditures could be obtained from a sample on the basis of either "numbers" of checks made out for defence relative to non-defence or on the basis of "sums of values". It would be easier for the Soviets to cheat if the former method is used since they could simply make some non-defence payments in numerous checks of small denominations.

One problem with this technique might arise if the Soviets made some of their defence expenditures in a few large aggregated amounts which would likely not be caught in the random samples. This difficulty could be avoided by requiring the Soviets to submit their checks in the form of cumulated totals.

The system outlined would require that the Soviets refrain from making large expenditures in cash. As well, they would have to systematize their accounts and payment systems in such a way that it would be possible to devise a means of taking random samples of checks (e.g. serialize checks using IBM-type clocks.)

In order to prevent hiding of military expenditures under other budget categories at the level of individual payments, the verifying body would have to be allowed the privilege of rigorously auditing selected checks taken from the random sample to make sure that they were ostensibly made. The number of checks to be so audited would depend on the size of the sample and the extent of falsification one wished to detect. Nevertheless, it is probable that thousands of checks would have to be audited.

<u>Total Expenditure (Budget Plus Non-Budget)</u>: This approach would require a random sample of all payments made through Gosbank, not merely payments on the budget accounts. It is likely that the Soviets would resist this since it involves higher costs of preparation and higher annoyance factors and since the verifying body would be put in a position where it could reconstruct the structure of the Soviet economy with a high degree of accuracy.

Separate Secret Accounts: As was the case for verification using additional budget data*, the possibility of separate accounts weakens the effectiveness of cerification by sampling since if "accounts are taken entirely out of the regular financial channels, then the random sample is effectively bypassed" (p.81).

To resolve the problem of verifying the absence of separate accounts it is theoretically possible that the verifying body could work back from physical military goods and services to the accounts in Gosbank using random samples. But this approach is not practicable since the Soviets could avoid detection by developing a correspondence between those items which are physically hidden and those expenditures which are hidden in the accounts. In addition, there is no way of getting a random sample of the physical counterpart of military expenditures.

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* See abstract J5(A75).

PROPOSAL ABSTRACT J7(A62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) Literature survey - budgetary analysis
   b) Records monitoring - personnel
   c) On-site inspection - selective

3. Source:
   Deutsch, Karl W. "Communications, Arms Inspection and National Security". In Preventing World War III: Some Proposals, pp. 62-73. Edited by Quincy Wright, William M. Evan and Morton Deutsch. New York: Simon and Schuster, 1962.

4. Summary:
   To supplement conventional ground or air inspections on a reciprocal or international basis, Deutsch recommends first content analysis of a country's mass media as well as materials used in the institutions of indoctrination of a country such as schools. The goal would be to detect the psychological groundwork needed for clandestine preparations for large scale war. Second, Deutsch suggests the mutual or international registration of all scientific and technical personnel. Sampling by inspectors could determine the whereabouts of these personnel and their accessibility. Third, budgetary allocations might be inspected. Budgets should therefore be publicized and budget-making organizations should be open to inspection. Finally, exchange of personnel particularly in the scientific fields and in budgetary organizations would be helpful.

PROPOSAL ABSTRACT J8(A58)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   Literature survey - budgetary analysis

3. Source:
   Burkhead, Jesse. "The Control of Disarmament by Fiscal Inspection". In Inspection for Disarmament, pp. 75-84. Edited by Seymour Melman. New York: Columbia University Press, 1958.

4. Summary:

Using the US system of fiscal administration as a model, the author examines the feasibility of controlling disarmament by examination of fiscal records. It is assumed that inspectors would have access to all financial records of individual agencies (eg. budget presentation, books of account and internal audit) as well as the government's overall financial records.

Two disarmament cases are considered. First, after disarmament had been operative for several years and the US military budget had been greatly reduced then any large military expenditures in violation of the agreement could be detected by fiscal inspection. In the second case, when military spending is at high levels, fiscal inspection could not be expected to reveal moderate expenditures on weapons in violation of an agreement. The US fiscal system is not designed to thwart complicity; if there were agreement among a dozen key officials, moderate expenditures could be hidden successfully. The author reviews several characteristics of the US fiscal system which would contribute to the ineffectiveness of fiscal inspection as well as several ways of disguising the expenditures within the existing budget.

CHAPTER K

INTERNATIONAL EXCHANGE OF INFORMATION

An international exchange of information is a system of providing information between the parties of an arms control agreement for the specific purpose of verification. It is closely related in many aspects to records monitoring and literature surveillance.

The use of an international exchange of information has been suggested as a verification technique for a number of arms control problems. It has, for example, played an important role in proposals for establishing international networks to monitor a nuclear test ban using seismic sensors. It has also been suggested as an important element for verifying a CW production ban. Indeed, in its widest meaning, it is one of the most pervading notions regarding verification.

International exchange of information can take a number of forms. First, states may make declarations. A declaration might be given once, for example, when a treaty comes into force, or it might be repeated periodically. Declarations can convey a wide variety of information. They may for example provide lists of existing stocks of weapons, installations or activities. On the other hand, they may merely involve an assertion by high government officials of compliance with an obligation. The essential difference of a declaration from other forms of information exchange is that it is a public statement to the world at large, not directed exclusively to other parties of a treaty or to some international body.

A second form of international exchange of information involves direct exchange between the parties. In this type of scheme analysis of the data is undertaken by the parties themselves. If desired such a system could be less open to the public at large and to other states, than a declaration. Also this method can handle a much greater volume of data than can a declaration. As is the case with declarations, the type of information exchanged can vary considerably.

A third type of information exchange involves an intermediate step between the sender and ultimate receiver in the form of some international body. Reports from state's parties are sent to the international body which can then perform one of two basic activities. It can, at one extreme, merely distribute the information amongst the parties to the treaty or it can undertake the analysis of the data and distribute its conclusions.

The information which is exchanged derives, of course, from national sources under the control of national governments. It is therefore possible that without some independent method of checking the quality of the data the information given could be incomplete or in some way misleading. Thus information exchange is unlikely to be completely acceptable as a method of verification in itself, except possibly in cases where no other means of verification presents itself and the objective is sufficiently desirable to warrant accepting a reasonable risk. However used in conjunction with other methods which can provide some confirmation of the information provided it can be a valuable ingredient in verification and moreover could promote confidence building.

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Other weapons of mass destruction	1
General and complete disarmamemnt	3
Any arms control agreement	2
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K1(A58)
K2(G68)

PROPOSAL ABSTRACT K1(A58)

1. Arms Control Problem:
   Nuclear weapons - fissionable materials "cutoff"

2. Verification Type:
   a) International exchange of information

3. Source:
   Penrose, L.S. "Radiation, Public Health and Inspection for Disarmament". In Inspection for Disarmament. Edited by Seymour Melman. New York: Columbia University Press, 1958.

4. Summary:
   This proposal is based on two assumptions:
   1) Organizations intending to conceal clandestine production of fissionable materials would be forced to forego certain protective measures in order to remain as inconspicuous as possible.
   2) If such an organization did use protective measures, they would be readily detectable.

   On the basis of these assumptions, it is proposed that hospitals could be instructed to report on unusual frequencies or instances of radiation sickness and other ill-effects resulting from exposure to radioactive materials.

   In addition to this measure, inspectors could be on the lookout for evidence of protective measures being taken in certain plants.

PROPOSAL ABSTRACT K2(G68)

1. Arms Control Problem:
   Nuclear weapons - peaceful nuclear explosions

2. Verification Type:
   a) International exchange of information
   b) On-site inspection - selective
      - non-obligatory
   c) International control organization

3. Source:
   Italy. "Working paper on underground nuclear explosions", ENDC/234, 23 August 1968.
   See also: ENDC/250, 22 May 1969.

4. Summary:
   Regulation of explosions for military purposes and those for peaceful purposes should be treated separately. Concerning the latter, the government conducting the PNE should inform the UN before carrying out the explosion, giving all necessary details (date, locality, depth, purpose, yield). All explosions not so announced would be deemed military in purpose. ENDC/250 modifies this idea slightly by suggesting that notification be given to the international service for

K3(G70)

PNEs to be set up by the IAEA.

Italy also proposes that governments conducting PNEs should invite foreign experts, chosen and approved by them, from non-nuclear states to observe the explosions.

PROPOSAL ABSTRACT K3(G70)

1. Arms Control Problem:
   Chemical and biological weapons

2. Verification Type:
   a) International exchange of information
   b) Literature survey
   c) Complaints procedure
   d) International control organization

3. Source:
   Sweden. CCD/PV. 480, 21 July 1970.
   See also: - CCD/PV. 463, 9 April 1970.
   - ENDC/PV. 425, 5 August 1969.
   - ENDC/PV. 391, 20 August 1968.

4. Summary:

This abstract focusses on a series of statements made by Sweden. That country's suggestions in ENDC/PV. 391 are used as the organizing foundation for the discussion which follows. How these original ideas are dealt with in later Swedish statements is also included.

1) A "universal openness" about CBW activities in the scientific literature is desirable. (ENDC PV. 391). In CCD/PV. 463 Sweden points out that this "openness" must concern the chemical agents themselves and, if possible, the whole weapons systems involved. The notion about "openness" of the scientific literature seems to have been de-emphasized in the Swedish statements of 1970.

2) An international organ such as the World Health Organization could undertake to collect, systematize, and disseminate all information on CBWs available from national and scientific sources (ENDC/PV. 391). From this original statement it appears that the international body would receive voluntary submissions by states as well as review open literature sources. The nature of the international body is elaborated in CCD/PV. 463, where it is stated that the body might be an existing specialized UN agency or a general international disarmament organ. In ENDC/PV. 425 Sweden suggests that states undertake "to register with the Secretary General of the UN, relevant scientific and technical material which could then be organized and published by competent staff". In CCD/PV. 480 it is made clear that states are to be obligated to report to the international body such relevant data as is agreed upon.

Related to the idea of an international body receiving reports and surveying open literature is the suggestion made in ENDC/PV. 425 that there might be provision "for international meetings under the aegis of the UN to evaluate scientific and technical developments within biology and chemistry from the point of view of possible risks of breaches of the undertakings in the convention".

3) A system of periodic reporting could be developed under which states would transmit information about resources, stocks, laboratories, personnel employed, research in process, future plans, etc. Research and production requirements for peaceful applications would be indicated in these reports. Agreement would be necessary on the precise kind of scientific activities that would be reported in this fashion (ENDC/PV. 391). Sweden, in ENDC/PV. 425 proposes "generally worded obligations for the parties to take part in an informal exchange of information on scientific and technical development". Also, as discussed under item 2, Sweden suggests that an international body be the recipient of such information. This is even more clearly stated in CCD/PV. 463. In CCD/PV. 480 both the idea of an exchange of information between the parties and reports to an international body emerge clearly as separate elements.

4) More active steps and a gradually expanded verification system would be needed to check against possible gaps in the flow of information or suspicious trends, to press for further information and to question the appropriateness of certain activities. This, in effect, would constitute the beginning of "verification by challenge". (ENDC/PV. 391) The essential ideas of this suggestion appear again in CCD/PV. 463 where Sweden states that in regard to complaints, it prefers a procedure in several stages which gradually and with increasing seriousness would seek clarification and which, as far as possible, helps to reduce tensions. In CCD/PV. 480 Sweden refers to an undertaking whereby the parties would consult and cooperate with each other and with the responsible international agency in solving any problems with regard to the treaty and facilitate any inquiry concerning compliance.

In CCD/PV. 463 Sweden suggests with regard to the complaints procedure that recourse would first be to the Secretary General of the UN who would automatically conduct an investigation before reporting to the Security Council. This procedure would keep separate the functions of fact finding and of political judgement. This idea seems to disappear, however, by CCD/PV. 480 where Sweden refers only to a provision for lodging a complaint with the Security Council.

5) Some sort of voluntary on-site inspection, involving mutual visits to laboratories by scientific experts. This idea is not mentioned in the three subsequent statements by Sweden (ENDC/PV. 391).

Additional points introduced by Sweden in the later statements but absent in ENDC/PV. 391 include the following. In CCD/PV. 463 Sweden suggests that verification techniques such as the use of sensors and records monitoring which may already be applied by national agencies, may become more widespread in the future. But it would be premature to create a fully fledged system involving the use of these methods by an international agency. The costs in terms of financial resources, manpower and political discomfort would be too great.

In CCD/PV. 480 Sweden adopts from the Socialist draft convention,* the idea of an undertaking by each state not to permit any legal or physical person on its territory to provide to any recipient, any chemical or biological agent which might be diverted from peaceful uses to military uses, unless the transfer is reported by the state party to the responsible international organ. Sweden also suggests the need for a provision to ensure that the safeguards would not hamper scientific, technical or economic development of the parties.

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* See Abstract I6(G69).

PROPOSAL ABSTRACT K4(A72)

1. Arms Control Problem:
   Biological weapons

2. Verification Type:
   International exchange of information

3. Source:
   Myrdal, A. The Game of Disarmament. New York: Pantheon, 1972.

4. Summary:
   The author notes that the Convention on Bacteriological (Biological) Warfare (1972) fails to include any verification techniques, and proposes that a requirement be made that states report measures taken to comply with the Treaty, such as the diversion of production facilities to peaceful purposes. A system of accounting for types and quantities of agents and equipment available for prophylactic research is also proposed.

PROPOSAL ABSTRACT K5(G72)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) International exchange of information - declarations
      - reports to international body
   b) Complaints procedure - consultation and cooperation
   c) International control organization

3. Source:
   United Kingdom. CCD/PV. 575, 8 August 1972.

4. Summary:
   According to the UK, any comprehensive ban requires a certain amount of on-site inspection as part of its verification scheme. If this is unacceptable,

   > ...a limited agreement might be possible on a basis of declarations of national stocks and declarations of national productive capacities provided by member states to an appropriate international body, giving the fullest information on the use by a state of chemical products that would be diverted to CW production by states members of the convention, and there would have to be opportunity for consultation and requests for further information to be handled through the international body concerned. Such a regime would be supported by such national verification techniques as today exist.

K6(A80)

PROPOSAL ABSTRACT K6(A80)

1. Arms Control Problem:
   Chemical weapons - production
   - stockpiling
   - destruction of facilities
   - destruction of stocks

2. Verification Type:
   a) International exchange of information
   b) On-site inspection - selective
   - non-obligatory

3. Source:
   Lundin, S.J.* "Confidence-building Measures and a Chemical Weapons Ban", in: Stockholm International Peace Research Institute, Chemical Weapons: Destruction and Conversion, London: Taylor and Francis, 1980, pp. 139-151.

4. Summary:

Lundin argues that in certain circumstances, verification of some undertakings in an arms control treaty may not be possible (eg. too intrusive to be politically acceptable or too expensive). In such situations, obligatory confidence building measures might be employed in lieu of verification. The author considers CBMs to encompass information given without opportunities for verification. He points out, however, that obligatory CBMs should not be considered as a substitute for international verification measures. They should only be contemplated when agreed intrusive verification may not be technically feasible.

Because of the extremely complicated relations between civilian and military conditions involved in a CW convention, obligatory CBMs may be highly relevant. Continuously expressed commitment to a cause (in the form of a continual supply of information on the matter) may make it politically difficult for a country to violate a convention. Further, nationally provided information, perhaps provided over a long time,should also be useful if intrusive international control could be instituted by means of complaints to a consultative committee.

For a CW convention, Lundin suggests consideration of several CBMs. Before the convention, mutual visits to production facilities might be invited. As demonstrated by workshops organized by the FRG and the UK in 1978, these can be done without disclosing industrial secrets. Also declarations on possession of chemical weapons, cooperation on CW protection, and monitoring scientific and technical developments might be considered.

After a convention comes into force the parties might voluntarily invite observers to military manoeuvres when anti-CW training was practiced and to Nuclear, Biological, and Chemical (NBC) protection

* National Defence Research Institute, Stockholm, Sweden.

schools. Obligatory CBMs might also be part of the convention regime. For example, when a CW facility and agents are to be converted to civilian use more extensive information than would otherwise be required might be demanded. Such information might include:

a) reasons why the material has to be converted instead of destroyed;
b) details of amounts of CW agents to be converted and the time schedule;
c) naming the facilities where the conversion will take place; and
d) identification of where stockpiles of the materials are located.

PROPOSAL ABSTRACT K7(G72)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - production

2. Verification Type:
   a) International exchange of information - declarations
   b) Short-range sensors - monitoring devices
   - seals
   c) On-site inspection - selective
   d) Records monitoring - economic
   e) Complaints procedure - consultative commission
   - referral to Security Council
   f) International control organization
   g) Review conference

3. Source:
   United States. "Work programme regarding negotiations on prohibition of chemical weapons". CCD/360, 20 March 1972.

4. Summary:
   The paper sets forth some considerations which the USA believes are relevant to the question of a prohibition on CWs, including verification. According to this paper states might be satisfied with a lower initial level of assurance if the disarmament process occurred in stages. With regard to verification the paper assesses a number of techniques.
   1) Seals and monitoring devices: These are used to ensure continued inactivity of "mothballed" facilities. They are particularly appropriate for a phased approach to a ban in which CW production facilities are shut down but

K7(G72)

not initially dismantled.*

2) Information exchange: Given the complexity and growth of the chemical industry this technique could be useful. Possible types of information which might be exchanged include:
   a) quantity, types and uses of organophosphorus products;
   b) quantity, types and uses of dual purpose chemicals; and
   c) intended use of major chemical production facilities.
3) Declarations: Two types of declarations might be considered:
   a) Periodic declarations regarding activities relevant to an agreement (e.g. annual reaffirmations of compliance with the agreement; annual statements of production figures of certain substances). Such declarations might be issued from the highest government levels to emphasize their continued commitment to the agreement.
   b) Lists of facilities capable of handling highly toxic materials and their location. These declarations would help verify a prohibition on production.**
4) Remote Sensing Devices: There does not seem to be significant prospect in the near future for the development of long range sensors that could detect manufacture of storage of CWs. Problems arise with regard to detection sensitivity and to distinguishing between prohibited and non-prohibited substances.
5) Inspection: This is probably the most efficient and direct way of resolving queries about implementation of a ban at a given site. It would be necessary to agree as to how the location and nature of visits would be chosen.
6) Monitoring of imports and shipping: Detection of a percentage increase in quantities of certain chemical substances imported might be useful for verifying a ban.
7) Consultative body: The possibility of a provision for a consultative body might be considered. Such a body could offer additional assurance to parties concerning implementation of the agreement. Its functions might include:
   a) keeping abreast of the military potential of new developments in chemistry;
   b) classifying new chemical substances;
   c) receiving reports from parties regarding their own compliance;
   d) receiving complaints from parties regarding the compliance of others;
   e) arranging inspection visits; and
   f) organizing the review conference.

   A number of matters relating to the structure and powers of this consultative body must be considered before it is established (e.g. powers, membership, relationship to other international bodies, funding, staff, etc.)

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* See also: United States, CCD/332, 5 July 1971, abstract G8(G71). and CCD/498, 29 June 1976, abstract G7(G76).

** See also United States, PV. 613, 17 July 1973.

8) Security Council: A provision for referral of complaints to the Security Council might be considered for inclusion in a treaty.
9) Review Conference: A provision for a review conference might be considered.

PROPOSAL ABSTRACT K8(G76)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - production

2. Verification Type:
   a) International exchange of information - declarations
   - reports to international body
   b) Short-range sensors - monitoring devices
   - seals
   c) On-site inspection - selective
   d) International control organization

3. Source:
   United States. CCD/PV. 702, 13 April 1976.

4. Summary:
   The scope of a CW convention must be based on verification capabilities. It should, therefore, include only verification measures that might be of value for a first stage agreement banning the production of lethal agents and providing for the destruction of an agreed quantity of stocks. By taking this approach it would not be necessary to meet the stricter requirements for the control system of a comprehensive ban.
   The verification system would require the use of a variety of techniques. One method would be an exchange of information such as through declarations or periodic reporting to an international authority. But the effectiveness of these is limited, especially in societies with self-sufficient centralized economies. The information if provided would have to be in sufficient detail to be useful for verification but still protect commercial secrets. The example of the "familiarization exchange" provision of the Threshold Test Ban Treaty Protocol is suggested.* The information exchanged would include loca-

* See abstract I3(T74).

tion of facilities and their ownership, as well as quantities produced, imported, exported and consumed by use category. Information on activities related to CW defense (e.g. expenditures, R&D) would also be useful for building confidence.

The closing of plants could be verified by tamper-resistant seals and monitoring devices. Inspection, however, would be the best technique, especially for confidence building. Present proposals concerning inspection, including inspection by challenge, lack sufficient detail to permit their application. The USA suggests a number of questions as to inspection details which must be clarified. Finally, the Americans believe that verification of stockpile destruction can only be done adequately by on-site observation of the actual process.

Some sort of international verification organ is also necessary though the effective operation of the treaty must remain the responsibility of the parties. The international body's role would be that of an expert consultative organ to consider new scientific and technological developments, receive and discuss reports from parties, circulate reports, and arrange on-site inspections.

PROPOSAL ABSTRACT K9(G76)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - proliferation
   - stockpiling

2. Verification Type:
   a) International exchange of information - declarations (Article 2)
      - reports to international body (Article 8(a))
   b) National self-supervision - (Article 2(1)(e), Article 5))
   c) Complaints procedure - consultation and cooperation (Article 10)
      - consultative commission (Article 8)
      - referral to Security Council (Article 10(2))
   d) Short-range sensors - monitoring devices (Article 9)
      - seals (Article 9)
   e) On-site inspection - selective (Article 9, 10)
      - obligatory
   f) Review conference (Article 14)
   g) International control organization

3. Source:
   United Kingdom. "Draft convention on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction". CCD/512, 6 August 1976.
   See also: - CCD/PV. 720, 12 August 1976.
   - CCD/PV. 752, 12 July 1977.

4. Summary:

The draft treaty provides for declarations by the parties as to stockpiles and CW production facilities before the treaty comes into force (Article 2). It is also implicit in Article 2 that a national body be created to collect information for these declarations and to ensure compliance with the treaty. This element of self-supervision is reinforced by Article 5.

Article 8 provides for the establishment of a Consultative Committee of parties to oversee the work of the convention. Some of the duties of this body are to receive and evaluate periodic reports from the parties, conduct inquiries on request, verify the destruction of stockpiles, inform parties of results

K9(G76)

of verification procedures and to consult and cooperate with national organs.

On-site inspection by persons appointed by the Consultative Committee is provided for with respect to:

1) deactivated production facilities (including periodic inspections) (Article 9 (A,b)),
2) active chemical production facilities (Article 9(c)), and
3) destruction of stocks (Article 9(d)).

The use of the seals and monitoring devices is also provided for but only in regard to shutdown facilities (Article 9 (b)).

Article 10 provides for consultation directly between parties or through the Consultative Committee to resolve complaints. A party may also request an inspection directly or through the Committee. Referral to the Security Council of any complaint is also included.

In PV. 752 of July 1977, the UK responded to a number of criticisms which were levelled at the draft convention. First, with regard to the objection that commercial secrets might be disclosed if the provisions of the convention were implemented, the UK recognized this as a justifiable concern but pointed out that similar misgivings were raised concerning IAEA inspections of nuclear facilities, none of which have proved justified. The banning of CWs was, anyway, too important to allow commercial considerations to prevent progress.

Second, with regard to suggestions that it would be futile to monitor the activities of the chemical industry because of its size, the UK stated that this problem could be overcome by restricting reporting and inspection to those plants producing chemicals similar to CWs. Only random checks would be taken of other plants.

In response to a third criticism concerning possible disclosure of military secrets, the UK contended that the draft convention deliberately avoided giving the Consultative Committee control over the weapons and armed forces of the party being verified. Intrusive inspection would be undertaken only in relation to three activities: destruction of stocks, shutdown of CW plants, and production in civilian plants.

The UK also agreed with the suggestion that the best option might be to dismantle CW plants rather than merely shut them down. This would reduce the number of plants to be inspected.

As to the suggestion that a ban on CWs could be verified by satellite, the UK rejects this because of limited technical feasibility, cost and availability.

With regard to the use of national control comittees to verify the ban, the UK feels that such a method would be inadequate alone though it may play a part in a verification system which involves use of a number of methods.

Finally, concerning the use of declarations before the convention enters into force, the UK feels that this is important for the purpose of building confidence. While not being wedded to this approach, the UK believes it necessary that some sort of similar confidence building measure be incorporated into the convention.

PROPOSAL ABSTRACT K10(G75)

1. Arms Control Problem:
   Other weapons of mass destruction - environmental modification

2. Verification Type:
   International exchange of information

3. Source:
   Iran. CCD/PV. 680, 12 August 1975.

4. Summary:
   According to Iran the act of triggering environmental modifications would be invisible; only the effects would be detectable. Hence there would be considerable problems about detecting violations of the prohibition. Furthermore, somewhat like peaceful nuclear activities, it is difficult to differentiate peaceful from military programmes.

   Iran suggests that international registration of all environmental experimentation might be helpful as a control mechanism.

K11(A55)

PROPOSAL ABSTRACT K11(A55)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) International exchange of information
   b) Complaints procedure
   c) On-site inspection - selective

3. Source:
   Szilard, L. "Disarmament and the Problem of Peace". Bulletin of the Atomic Scientist 11, no. 2 (October 1955): 297-308.

4. Summary:

   This proposal follows a voluntary evidence principle whereby each state, seeking to make its own compliance with the agreement known, would provide other countries with sufficient evidence of its compliance. If a state fails to convince other states, they would be free to seek clarification. Should they fail to get satisfaction, they could abrogate the agreement.

   More specifically, in an agreement on general and complete disarmament, the first stage of which calls for destruction of 3/4 of all guns, tanks and other mobile equipment used for tactical warfare (including warplanes), each country would announce which weapons it plans to destroy and would invite all other parties to the agreement to observe and certify the destruction. To verify the end of production of these weapons, "a few" inspectors could be invited to station themselves in specified factories.

PROPOSAL ABSTRACT K12(A63)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) International exchange of information
   b) On-site inspection - progressive/zonal

3. Source:
   Polanyi, J.C. "First Step - Sealed Records Caches?" Disarmament and Arms Control 1 (1963): 5-21.

4. Summary:

This proposal seeks to provide a means of verifying the accuracy of declared weapons inventories in a manner that would postpone for as long as possible the necessity of implementing a system of general inspection. As such it is intended to preserve the military balance.

The proposal envisages the use of sealed records caches, each of which would contain lists of a specific set of weapons. The caches would be opened only when the appropriate stage of the disarmament process had been reached. Thus, the records would become available only just prior to the time inspection was to be carried out to verify the elimination of those particular weapons.

The contents of the caches would include inventories in each of the weapons categories specified, i.e. the missiles, aircraft, nuclear stockpiles, CBW stockpiles, warships, tanks, artillery and plants capable of producing these, and armed forces. Economic data would be included. The records in the caches should consist as far as possible of overlapping documents, drawn from many sources. In this way the possibility of cheating would be substantially reduced.

The author suggests that the caches be located on "neutral soil". Alternatively, each state could locate its caches in some visible and visitable site in its capital city. In either case the caches would be under international control.

K13(A64)

PROPOSAL ABSTRACT K13(A64)

1. Arms Control Problem:
   General and complete disarmament

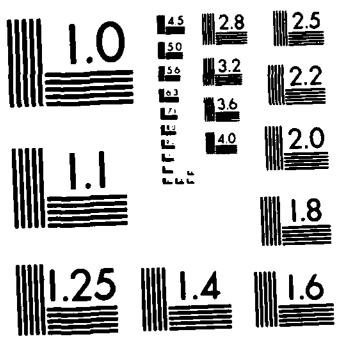
2. Verification Type:
   a) International exchange of information
   b) On-site inspection - selective
   c) Complaints procedure - referral to new international body
   d) International control organization

3. Source:
   Lall, Betty Geotz. "Information in arms control verification". Bulletin of the Atomic Scientists 20 (October 1964): 43-45.

4. Summary:
   The author suggests a procedure for verifying declarations about force levels made at the beginning of the disarmament process. First, each party prepares a list of all armaments to be controlled including information on numbers, characteristics, age and whether stationed in the country or abroad. Second, the declarations are submitted to the International Disarmament Organization which circulates them to the parties. The agreed number of arms are assembled for destruction under IDO supervision and the first IDO inspectors are stationed at production plants. Based on its own figures regarding the weapons stocks of other states, any party may challenge the declaration of another and ask the IDO to resolve the discrepancies. In response to such a challenge a country must provide information to justify its declaration. The IDO would then decide by majority vote what action, if any, should be taken. One possible action might be sending inspectors to one or more parts of the country to ascertain if force levels have been accurately reported. If an investigation is decided upon, the IDO would rule whether the armaments accumulated would be destroyed or whether the disarmament process should be postponed.

   The foregoing applies to verifying declarations and protecting against undeclared stocks of weapons. The verification of production limitations would be done by inspection.

AD-A124 775 COMPENDIUM OF ARMS CONTROL VERIFICATION PROPOSALS(U) 5/6
OPERATIONAL RESEARCH AND ANALYSIS ESTABLISHMENT OTTAWA
(ONTARIO) A CRAWFORD ET AL. MAR 82 ORAE-R81
UNCLASSIFIED SBI-AD-E750 745 F/G 5/4 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PROPOSAL ABSTRACT K14(A62)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) International exchange of information
   b) Records monitoring - personnel

3. Source:
   Woods Hole Summer Study. Verification and Response in Disarmament Agreements. Annex Volume I. Washington, D.C.: Institute for Defence Analysis, 1962.

4. Summary:
   This proposal seeks to control research and development by developing an international scientific community in which clandestine R&D programs would be more difficult to conceal. The system proposed would involve a voluntary exchange of technical journals and the holding of joint scientific meetings to create the proper ethos for the envisaged international scientific community. An international registry of scientists with semi-annual entries disclosing their current assignments and the nature of their work would be established. Finally, an international control organization might carry out random inspections (by telephone perhaps) to verify the accuracy of entries in the registry.

K15(A65)

PROPOSAL ABSTRACT K15(A65)

1. Arms Control Problem:
   a) Any arms control agreement

2. Verification Type:
   a) International exchange of information
   b) On-site inspection - selective

3. Source:
   Barton, J.H. "Inspection of Technology". Disarmament and Arms Control 3 (1965): 41-49.

4. Summary:
   The author offers two suggestions for verifying restrictions of military research and development:
   a) Free and open exchange of scientific information, as well as internationalization of some R&D (i.e. space exploration) should be instituted.
   b) All R&D programs exceeding a specified size could be placed under international observation.

CHAPTER L

NATIONAL SELF-SUPERVISION

The essence of this idea is that each state is to be held responsible for ensuring compliance with an arms control agreement within its territory. This principle is already well established in international law. The rule of pacta sunt servanda - that treaties are binding on parties and must be performed in good faith - is a fundamental principle of the customary law of treaties, according to the International Law Commission's Commentary on the Vienna Convention on the Law of Treaties of 1969, Article 26. It has been held by the Permanent Court of International Justice and by a number of international arbitration tribunals, that the principle of performing the treaty in good faith is an integral part of this rule.

Proposals concerning self-supervision frequently attempt to be more specific than this, however, by imposing an obligation on the parties to institute appropriate laws and administrative procedures so as to ensure compliance with the treaty within their territorial jurisdiction. Some proposals also require the establishment of a national control body to undertake supervision of compliance.

The obvious difficulty with the idea of self-supervision is that it has the potential for creating a situation where the thief guards the gold. When a national control organization is envisaged there appears more substance to the deterrent. But the credibility of this organ depends primarily on its independence from the government of the state within which it is to carry out its supervisory role. In some instances it may be difficult to judge to what degree an organization is independent.

Assuming that an independent organ is created, it is then necessary to consider whether the organ will have adequate resources and whether the organ will be given sufficient access to records and facilities to be able to carry out its functions.

On a more positive note, a national control organ for monitoring a CW production ban could prove doubly attractive to states if it could be combined with a domestic system for monitoring chemical production for the purpose of pollution control. It seems quite reasonable, that the requirements of systems designed to meet both objectives would be compatible in many ways. Consequently, a single, dual purpose agency might prove more efficient and provide substantial savings. An analogous situation exists already in many states with regard to national supervisory bodies for the control of dangerous and expensive nuclear materials. Such bodies enforce safeguards so as to protect the environment and the health of the public, and to comply with obligations under the NPT.

It is sometimes suggested that any national control bodies which are created be required to report periodically to an international organization. Related to the idea of requiring international reports, is that of incorporating a clearly defined form of international supervision of the domestic regulatory mechanisms, especially any national control organ. The advantage of this notion is that it would help ensure that domestic rules were being enforced properly by states and thereby increase the faith of other parties in the deterrent value of the national self-supervision system.

As an alternative to specific requirements for domestic control mechanisms, a proposal for national self-supervision may include the obligation to give international exposure to laws, administrative procedures, etc., enacted domestically to ensure compliance. This isea, in itself, is rather inoffensive. It still begs the question of ensuring that the domestic rules are enforced properly.

Another idea sometimes suggested in connection with self-supervision is that domestic provisions (i.e. laws, regulations, control bodies, etc.,) might be "harmonized" between states by developing through international negotiations, some standard provisions or perhaps a model form of national control mechanism. Such an endeavour has considerable merit for defining essential standards and for ensuring that all states are aware of the basic requirements of an effective regulatory mechanism. However, any such model would have to be very general. National regulatory mechanisms would be substantially individual in character because of differences in domestic political and legal systems between countries.

In many cases, it is probable that undertaking arms control obligations will necessarily entail some form of domestic mechanism for ensuring compliance. This may be true regardless of whether specific provisions of the agreement require such a mechanism especially if a party assumes the obligation to provide detailed data about a complex matter such as the production of chemicals. However, proposals concerning national self-supervision frequently seek to rely on the method as a substitute for more intrusive verification techniques. When such proposals are framed generally, merely stating the obligation to establish domestic mechanisms for enforcement, they have little substance from the perspective of verification.

<u>Contents of Chapter L:</u>

Arms Control Objective	Number of Proposal Abstracts
Chemical and/or biological weapons	12
New weapons of mass destruction	2
	14

PROPOSAL ABSTRACT L1(G70)

1. Arms Control Problem:
   Chemical and biological weapons

2. Verification Type:
   a) National self-supervision
   b) Remote sensors - aerial
      - satellites
   c) Records monitoring - economic
   d) Literature survey
   e) International exchange of information - declarations
      - reports to international body
   f) On-site inspection - selective
      - non-obligatory
   g) Complaints procedure - consultation and cooperation
      - referral to new international body
      - referral to Security Council
   h) International control organization

3. Source:
   Yugoslavia. CCD/PV. 465, 6 April 1970.
   See also: CCD/302, 6 August 1970.
   CCD/377, 20 July 1972.

4. Summary:
   The following is a summary of the Yugoslavian statements in the above sources.

PV. 465 — 1) Measures of self-control:*

a) Laws putting under civilian administration or control all institutions now engaged in R&D, and production of CBWs.

PV. 465 — b) Laws prohibiting R&D, production and stockpiling of agents for CB warfare. Decisions on the elimination of stocks and abolition of testing fields as well as all installations producing the weapons. An exception would be made for continuation of work for the purposes of protection and riot control.

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* The enforcement of these laws would be left to the individual state. These self-control measures represent the most important verification procedures according to Yugoslavia.

L1(G70)

PV. 465 c) Cessation of military training in the use of CBWs including deletion from military manuals of all rules and regulations pertaining to ways of using and conditions for use of CBWs.

CCD/302 d) Laws requiring obligatory publication of certain data such as names of institutions and facilities engaged in or which could engage in the prohibited activities. Other laws would require the compilation and reporting of data on production of material and agents which could be used as CBWs as well as the reporting of this information to an international organization.

PV. 465 2) Indirect control by international organization or each party individually:

This involves the collection and analysis of data from each country pertaining to the expenses in certain fields of activity, to the utilization of certain raw materials, semi-finished products and final products, and to the development of scientific and research work which could indicate whether or not there was any activity contrary to the prohibition of CBWs. (This would complement procedure 1(d) above.)

PV. 465 3) Measures of international control:

a) Listing by all parties of all institutions, factories proving grounds, etc. which have been engaged in R&D and production of CBWs as well as institutions which could engage in such activity (This is complementary to 1(d) above).

PV. 465 b) Governments should on their own initiative provide for appropriately regulated access to show the non-existence of any forbidden activity. This corresponds to Sweden's idea of "verification by challenge".

PV. 465 c) The possibility of control from the air by satellites or other devices for remote detection.

CCD/302 4) Complaints procedure:

In the case of doubts about implementation of the treaty, any party could enter into consultations with the suspected party to clarify the situation. In case of suspicion of a violation, the complainant should inform other parties and submit its evidence to the international control organ. The international organ would contact the suspected state to conduct inquiries. If this procedure does not clarify the situation satisfactorily, the suspected state may offer to allow verification by on-site inspection. If there is no satisfactory explanation after the above procedures, the complainant could address itself to the Security Council.

In CCD 377, Yugoslavia suggests some further measures. Under national measures of self-control there might also be the following:

1) Statements by governments, at the time of the treaty's entering into force, about national activities up to that time regarding CWs.
2) Enactment of national legislation and administrative acts regarding:
   a) the organization and functioning of the national system of self-control including establishment of a group of experts with full authority to act nationally and cooperate with international bodies.
   b) the relationship between national and international control and national obligations to submit regular reports of a uniform standard.
   c) organization of a control system for imports and exports of all chemical substances.
3) Declassification of all data on R&D and production of CWs.
4) The exchange of national experts between states.

Yugoslavia also suggests in CCD/377 the establishment of an international control organization. This body would have the functions of:

1) reviewing the operation of the treaty and fulfillment of obligations of parties;
2) stimulating and assisting mutual cooperation between parties;
3) analyzing and classifying new achievements in the chemical field; and
4) carrying out on-site inspections at the request of the UN Security Council.

This control body would include a council of experts which would conduct any inspections as well as make proposals concerning improvement of control systems. This body could also advise the Security Council about procedures for on-site control and appropriate sanctions against violations.

L2(G72)

PROPOSAL ABSTRACT L2(G72)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   National self-supervision

3. Source:
   Sweden. "Working paper on domestic legislation in Sweden regarding chemical substances". CCD/384, 8 August 1972.

4. Summary:

Considerable efforts are already being made by experts and organizations in fields other than disarmament to control the vast quantities of chemical agents which are used in civilian life. Disarmament negotiations and agreements might take advantage of the national and international control structures being developed for environmental and health purposes. These structures take the form of submission of statistics, licensing, etc. This working paper reviews Swedish domestic legislation regarding chemical substances.

PROPOSAL ABSTRACT L3(G75)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   National self-supervision

3. Source:
   Japan. "Working paper concerning the scope of chemical agents that have justification for peaceful purposes and an example of a national verification system". CCD/466, 14 August 1975.

4. Summary:
   The control system established under the Japanese domestic "Law Concerning the Screening of Chemical Substances and Regulation of their Manufacture, etc.", may offer an example of the functions of the national organ as suggested in CCD/420 and CCD/430,* for ensuring compliance with the obligations of a CW convention. The law is intended to screen chemical substances which require control prior to their production or importation, and to place the necessary controls on the substances thus screened in order to prevent pollution.

   The law provides for: a) the examination of any chemical substance listed, at any time; and b) the obligation to report intended production or import of any substance not on the aforementioned list, prior to its examination. These new substances are classified as "harmless" or "specified" substances. Specified substances are to be kept under observation.

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* See abstract L11(G74).

L4(A73)

PROPOSAL ABSTRACT L4(A73)

1. Arms Control Problem:
   Chemical weapons - research and development

2. Verification Type:
   a) National self-supervision
   b) International exchange of information
   c) Literature survey

3. Source:
   Reutov, O.A., N.N. Melnikov and J. Moravic. "Paper prepared for discussion at the working group meeting on 16-18 December 1972". In: Stockholm International Peace Research Institute, Chemical Disarmament: Some Problems of Verification, especially pp. 43-44. Stockholm: Almqvist and Wiksell, 1973.

4. Summary:

To control the research and development stage of CW agent and weapons production, several measures are proposed. First, in order to discourage research specifically concerned with weapons development, it is suggested that national and international patent laws be changed to make CW agents and weapons unpatentable. Such a measure would accompany the termination of existing patents for such agents and weapons.

To supplement this, national control agencies should have access to all research on the toxicity of various chemical compounds, or on the testing of their suitability for military use.

Annually or once every two years, international conferences of experts should be convened:

> ...to consider new information on toxic substances... Representatives of the national control agency should become acquainted with the scientific research work both by studying the relevant published materials and by visiting laboratories and conducting discussions with the scientific staff. The list of such laboratories should be compiled by the national control agencies in every country where a system of national control exists. (p.44).

The national control agency should also be empowered to verify experimentally some data if the data furnished by the scientific research laboratory raises doubts. The agency should have the right to publish information on substances with high toxicity. Exchange of information on chemical compounds between governments party to the convention would be useful as well.

PROPOSAL ABSTRACT L5(G72)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) National self-supervision
   b) International exchange of information
   c) Complaints procedure - consultative commission
      - referral to Security Council
   d) International control organization

3. Source:
   Sweden, CCD/PV. 569, 18 July 1972.

4. Summary:

Referring to the Socialist States' draft CW treaty of March 28, 1972*, Sweden suggests a number of alterations. Concerning the provisions for verification, Sweden believes that Article 4, which deals with measures of national self-supervision, should include more specific references to the issuing of laws and regulations for control of civilian production and for the establishment of national committees to check compliance. A commitment should be included that all such laws, regulations and enforcement measures will be made known internationally through registration. The use of declarations which would embrace statements about activities, facilities and present stockpiles, might also be incorporated.

Article 5 dealing with consultation and cooperation must also be made more specific. It should include rules about international exchange of information, the sequence and form of inquiry, and other agreed methods of verification.

The aspect of Article 5 dealing with international procedures should define some international machinery that could serve as guarantor that objective verification procedures would be available at the international level before recourse to the Security Council. Similarly, Article 6 which deals with referral of complaints to the Security Council must allow for an objective and separate fact-finding mechanism.

Attached to the treaty would be an annex defining those substances subject to the ban. This would be important for purposes of verification, providing some agreed standards of national implementation.

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* See abstract M5(T72). The verification provisions of this draft are identical to those of the BW Convention.

L5(G72)
L6(G69)

Another feature of the treaty should be a provision for the creation of a panel of experts to advise on matters of verification. This body might be attached to the Secretariat of the UN or perhaps to some interim form of international disarmament organization.

PROPOSAL ABSTRACT L6(G69)

1. Arms Control Problem:
   Chemical and biological weapons - destruction of stocks
   - production
   - proliferation
   - research and development
   - stockpiling

2. Verification Type:
   a) National self-supervision (Articles 4&5)
   b) Complaints procedure - consultation and cooperation
   - referral to Security Council*
   c) Review conference**

3. Source:
   Socialist States. "Draft convention on the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and the destruction of such weapons". Document A/7655, submitted to the UNGA, 19 September 1969.
   See also: - Union of Soviet Socialist Republics. CCD/PV. 454, 3 March 1970.
   - Revised draft presented in the UNGA, Document A/8136, 23 October 1970.
   - Socialist States, CCD/325/Rev. 1, Draft Biological Weapons Convention, 30 March 1971.

4. Summary:
   Under Article 4 each party becomes "internationally responsible" for compliance with the treaty by legal and physical

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* An amendment to the Socialist draft CBW convention was introduced on April 14, 1970 by Hungary, Mongolia and Poland (CCD/285). It involved the addition of a provision specifically allowing for referral of any complaint to the Security Council. This amendment was incorporated into the Revised Socialist draft CBW convention of October 23, 1970 as Article 7.

** The review conference provision was suggested by a number of states and was included in the Revised Draft of October 23, 1970.

persons within its territory as well as by its citizens outside its territory. Each party under Article 5 is also obligated to undertake "in accordance with its constitutional procedures, the necessary legislative and administrative measures" to ensure compliance with the convention.

Parties also undertake to consult and cooperate with each other with the view to resolving any problems which may arise in the application of the convention (Article 6).

5. Selected Comments of States:

Mongolia suggests (CCD/464, 14 April 1970) that one possible measure under Article 5 of the Socialist draft CBW convention would be the creation of a special government agency to ensure compliance with the treaty by persons within the state party's jurisdiction. An analogy is drawn to the provisions of the Single Convention on Narcotic Drugs (1961). Other possible national self-supervision measures include:

1) A national system of compulsory registration of the requirements and the quantity of production of CBW agents;
2) Strict control of import and export of such agents; and
3) Strict control of manufacture, import and export of equipment used to develop, produce and stockpile CBW agents.

PROPOSAL ABSTRACT L7(G70)

1. Arms Control Problem:
   Chemical and biological weapons - destruction of stocks
   - production

2. Verification Type:
   a) National self-supervision
   b) International exchange of information
   c) Complaints procedure - referral to Security Council
   d) International control organization

3. Source:
   Egypt. "Working paper containing suggestions on measures of verification of a ban on chemical and biological weapons". CCD/314, 1 September 1970.

4. Summary:
   A basic verification procedure should include the following:
   1) Each state agrees that within a certain time from entry into force of the treaty, it will undertake all legal, administrative and practical measures conducive to ensuring compliance with the prohibitions and the elimination of stockpiles. Each party agrees to inform the Security Council or some impartial international body, on the steps it has taken in this regard, as well as on the completion of destruction of stockpiles.
   2) Each state undertakes to forward relevant basic information to be agreed upon, to the impartial international body with a view to assisting the technical process of verification. The assistance of WHO, FAO and other international agencies might be appropriate at this stage.
   3) In the case of a possible violation, a report would be made to the Security Council which would take the necessary action.

PROPOSAL ABSTRACT L8(A73)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks

2. Verification Type:
   a) National self-supervision
   b) International exchange of information - declarations

3. Source:
   Stockholm International Peace Research Institute. *Chemical Disarmament: Some Problems of Verification*. Stockholm: Almqvist and Wiksell, 1973, pp. 25-26.

4. Summary:
   According to this proposal, an agreement calling for the destruction of CW stockpiles would be verified by means of a national control agency* conducting on-site inspection of the destruction process. It would witness and confirm both the completeness of the destruction of the stockpiles, as well as non-contamination of the environment by undesirable products. It is suggested further that following the destruction of the CW stockpiles a solemn declaration should be made by the parties concerned, officially confirming the observance of the stipulations of the convention.

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* See abstract E4(A73) for a description of the sort of control organ envisaged by the SIPRI study.

L9(G73)

PROPOSAL ABSTRACT L9(G73)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - production

2. Verification Type:
   a) National self-supervision
   b) International exchange of information - declarations
   c) On-site inspection - selective
   d) Remote sensors
   e) Complaints procedure - consultation and cooperation
   - referral to Security Council
   f) International control organization
   g) Review conference

3. Source:
   Argentina, Brazil, Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Sweden, and Yugoslavia. "Working paper on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction". CCD/400, 26 April 1973.

4. Summary:
   The purpose of a verification system is to give every party a reasonable assurance of compliance with the prohibition. Such assurance can be provided through a combination of national and international measures which complement each other. At least the following elements should be included:
   1) Self-control by states:
      a) Declarations, upon entry into force of the treaty, regarding national activities related to the production and development of CWs especially concerning destruction of existing stockpiles;
      b) Measures such as enactment of laws aimed at implementing the treaty;
      c) Organization of a national system of control and a control body with authority to cooperate with the international organ; and
      d) Provision for informing the international control organ of these measures of self-control.
   2) National means of verification:
      These should be used in accordance with international law. Consultation and cooperation over complaints should be provided for, including procedures within the framework of the UN.
   3) International measures of certification:
      These should be undertaken by a qualified and independent international control organ and results should be made available to all parties. The functions of this organ might include collection, analysis and distribution of relevant data and assistance to parties in creating a national self-control mechanism and in developing national

verification methods. Parties should render all possible assistance to the international organ including relevant technology at the disposal of the parties. "Non-recurrent" international inspection to verify stockpile destruction might also be provided for.

This verification system should be subject to review and possible improvements, taking into account new scientific and technological developments. The system should be designed and implemented to avoid disclosure of scientific and commercial secrets.

The complaints procedure would involve reference to the Security Council. It is also implied that the international control organ should undertake a fact-finding investigation before the complaint is referred to the Security Council.

5. Selected Comments of States:

The US commented on this proposal in detail. The following discussion summarizes its arguments in PV. 609, 3 July 1973 and PV. 613, 17 July 1973.

Concerning verification of stockpile destruction, there is a problem as to how to ascertain the extent of existing stockpiles. If declarations are relied upon, how is the accuracy of these declarations to be verified? The proposal suggests that "non-recurrent" inspection of the destruction process should take place. Does this mean that only a single short-lived inspection will occur? The problem with this is that the destruction process may take years. Furthermore, there may be need for inspections after the alleged destruction of stocks, should there be any evidence of a violation. The proposal also suggests that the inspection procedures be agreed upon after the treaty comes into force. This is unacceptable to the USA. The procedures for verifying an agreement should be agreed upon in detail before the treaty comes into force.

Declarations in a number of forms could be useful for providing information. But they have their limitations, amongst which is the possibility of undeclared facilities, activities or stocks.

The US agrees on the need for national legislation and administrative regulations but questions whether a new national control body is needed. Might not existing bodies suffice? Concerning national control the main issue is whether it alone will provide sufficient reassurance to other parties. This depends on the confidence other parties have that the national control body is independent from the government it monitors and the degree to which it has unimpeded access to all relevant facilities.

National means of verification will undoubtedly be used by states to which they are available but these techniques (e.g. remote sensing, economic monitoring and off-site observation) all have limited utility with regard to a CW ban.

The formality and complexity of the international organ should depend on the scope of the verification activities it is assigned. The US prefers a Consultative Committee because of its flexibility. Both raw data and results of the international organ's analyses should be made available to parties. The requirement of assisting the international body to develop international verification techniques must be tempered because of national security concerns of the parties (e.g. the secrecy of satellite capabilities).

The US agrees with the idea that there must be international investigatory procedures to ascertain the facts before recourse to the Security Council.

PROPOSAL ABSTRACT L10(G73)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - destruction of facilities
   - production

2. Verification Type:
   a) National self-supervision
   b) International exchange of information
   c) Literature survey
   d) Short-range sensors - seals
   - sampling

3. Source:
   Socialist States. "Working paper on ways of implementing control over compliance with the convention on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction." CCD/403, 28 June 1973.

4. Summary:
   The paper is mainly concerned with elaborating upon Article 4 of the Socialist Draft CW Convention* dealing with national self-supervision. Four developments might be considered:
   1) National Control Committee:
      This body should, by means of random verification, supervise the destruction of stocks, the closure or conversion to peaceful use of production facilities and the end of production of delivery systems. Composition of the body would

* The verification provisions of this draft CW treaty are identical to those of the BW Convention. See Abstract M5(T72).

be determined by the state party. It might include representatives of governmental and public organizations as well as experts. Modern chemical analysis, seals and on-site inspections would be used by the committee for verification. Reports of the committee would be submitted to the national government and could be published.

2) Exchange of information between parties:
This would be done on a voluntary basis and would involve discussion of data on new chemical substances for peaceful use.

3) Statistical analysis:
This would involve use of data from open publications on production, consumption, trade and storage of raw materials and semi-finished products. Production would be compared with consumption taking into account other variables. An excess of production over consumption would give grounds for assuming diversion to military use. Where data is missing estimates could be made.

4) Limitations on Patenting:
Patenting of chemical substances, weapons, equipment and means of delivery which are banned by the treaty should be prohibited and existing patents cancelled.

5. Selected Comments of States:

The US criticized this proposal on a number of grounds (PV. 624, 23 August 1973). First, the Americans contended that alone self-supervision is insufficient to assure other parties that violations will be deterred. CW stockpiling, production, and so on are carried out at the behest of the government of a state, not of private organizations within that state. Consequently, confidence in the control committee would depend on its independence from the government it is intended to monitor and its unimpeded access to relevant information.

Second, the Socialist State's proposal suggests that each party itself would determine the nature of the national control bodies. The US disagrees and contends that some standardized procedures would be needed.

The proposal also suggests that the national control committees would report directly to their governments, not to an international body. Thus, even if the committee had the confidence of other parties, there is no assurance that the government through which the information had to pass would not modify the reports.

Finally, the US criticized the limited nature of the proposed information exchange. It is to be voluntary and to deal only with new information.

PROPOSAL ABSTRACT L11(G74)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - production
   - proliferation
   - stockpiling

2. Verification Type:
   a) National self-supervision (Article 5)
   b) International exchange of information (Articles 2 & 6)
   c) Complaints procedure - consultation and cooperation (Article 7)
   - **referral to new international body** (Articles 5, 6 & 7)
   - **referral to Security Council** (Article 10)
   d) On-site inspection - selective (Articles 2(3), & 9)
   - non-obligatory
   - obligatory
   e) International control organization
   f) Review Conference (Article 17)

3. Source:
   Japan. "Draft convention on the prohibition of development, production and stockpiling CWs and on their destruction". CCD/420, 30 April 1974.
   See also: - CCD/413, 21 August 1973;
   - PV. 623, 21 August 1973.
   - CCD/430, 12 July 1974.

4. Summary:

The proposed Convention is to be composed of two sets of documents. First a broad, general ban on CWs is provided for in the treaty itself. Details of the substances to be banned and the extent of the general ban are to be included in annexes to the treaty. The annex defining scope might be based on either exclusion or inclusion of substances.

With regard to the draft treaty itself each party is obligated under Article 5 to take "any necessary measures" to ensure compliance with the Treaty and to notify the International Verification Agency (IVA) which national organ(s) is responsible for these measures. Periodic reports on the functioning of these national measures must be made to the IVA. The functions of the national control organ would include:

1) observation and supervision of national activities related to the subject of the treaty;
2) collection of statistical and other information;
3) preparation of the reports for the IVA; and

4) cooperating with the IVA especially with regard to supplying information requested by the IVA and accepting inspection.

The IVA is created under Article 6(1). Its functions include:

1) analyzing and evaluating reports from each party;
2) requesting explanations and conducting inquiries under Article 8;
3) conducting inspections under Article 9;
4) sending notifications and reports under Article 10;
5) consulting and cooperating with national organs;
6) recommending amendments to the Annexes;
7) sending observers under Article 2, to verify destruction of stocks and
8) carrying out decisions made by the conference of the parties.

The parties are to consult and cooperate with each other directly or through the IVA under Article 7. Complaints can be made directly to other parties or to the IVA which can then request further information and conduct an investigation (Article 8).

Inspection by invitation is provided for under Article 9(1). The IVA can also notify a suspected party of an impending inspection (Article 9(2)). A state party refusing such inspection must provide adequate reasons (Article 9(3)). The IVA also is required to send observers to verify the destruction of stocks and equipment under Article 2(3).

The IVA must notify parties of the results of its analyses and investigations. It may also, when necessary, report these to the Security Council (Article 10).

The verification scheme of the draft convention is further elaborated in CCD/430 which includes a descriptive chart of the proposed system. The reporting of statistical data constitutes the keystone of the draft convention according to this paper. Production activity is the most highly susceptible activity to verification because it contains a variety of elements. Reports submitted to the IVA by state parties would monitor movements from the unloading of raw materials or intermediates to the loading of end products. They would be concerned with seven substances related to organophosphorous CWs.

The minimum content of monthly reports to the IVA would include:

1) importers and amounts imported;
2) producers, amounts produced, loaded in stock and production capabilities;
3) wholesalers and amounts purchased and sold;
4) users and amounts used and
5) exporters and amounts shipped.

It is also pointed out in CCD/430 that the IVA would be given the right of free access to the national organ to check its records and data. A list of production facilities would also be provided to the IVA.

L12(A80)

PROPOSAL ABSTRACT L12(A80)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - destruction of facilities
   - production

2. Verification Type:
   a) National self-supervision
   b) International exchange of information
   c) International control organization
   d) Records monitoring - economic
   e) Short-range sensors - monitoring devices
   - seals

3. Source:
   Reutov, O.A. and K.K. Babievsky. "Some aspects of the problem of the destruction of chemical warfare agents". In Stockholm International Peace Research Institute, Chemical Weapons: Destruction and Conversion, pp. 117-121. London: Taylor and Francis, 1980.

4. Summary:

It is generally felt that on-site inspection of the destruction of chemical weapons raises apprehensions concerning civilian destruction processes and military secrets. It is, therefore, important to establish the level of intrusion for reasonable assurance of compliance. In the authors' opinion, the destruction should be verified by representatives of the respective national control agency, cooperating effectively with an international consultative commission. After the destruction of existing stockpiles, an official government declaration would be made.

Conversion of CW plants to civilian uses should be carried out under the on-site supervision of representatives of the national control system. It is reasonable in this case that devices be installed to monitor the products manufactured. These devices would be sealed and accessible only to the national control agency. For the control of dual-purpose agents mainly statistical methods should be used.

The authors believe that an international consultative commission could play a role in economic data reporting. It also seems possible that this commission would need to have a sample analysis laboratory for standardizing analytical and data-reporting methods.

PROPOSAL ABSTRACT L13(G74)

1. Arms Control Problem:
   Other weapons of mass destruction - environmental modification

2. Verification Type:
   a) National self-supervision (Article 4)
   b) Complaints procedure - referral to Security Council (Article 6)
   c) Review conference (Article 9)

3. Source:
   Union of Soviet Socialist Republics. "Draft international convention on the prohibition of action to influence the environment and climate for military and other purposes incompatible with the maintenance of international security, human well-being and health". Annex to UNGA resolution A/RES/3264 (XXIX), 1974.

4. Summary:
   The control provisions of this draft treaty are very similar to those of the BW Convention and the Socialist draft CW treaty of 1972.* Article 4 requires parties to adopt "the necessary measures" to prohibit activities within their territory that are banned by the treaty. Article 6 provides for complaints about violations to be brought before the Security Council. Each party is also obligated to assist the Security Council in its investigations. But unlike the BW Convention, the provision for consultation and cooperation between the parties prior to recourse to the Security Council is absent.

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* See abstract M5(T72).

PROPOSAL ABSTRACT L14(G75)

1. Arms Control Problem:
   Other weapons of mass destruction

2. Verification Type:
   a) National self-supervision (Article 2)
   b) Complaints procedure - consultation (Article 3(1))
      - referral to Security Council (Article 3(2))

3. Source:
   Union of Soviet Socialist Republics. "Draft agreement on the prohibition of the development and manufacture of new types of weapons of mass destruction and new systems of such weapons". Annexed to UNGA Resolution A/RES/3479 (XXX), 1975. It was submitted to the CCD as CCD/511, 3 August 1976.
   See also: CCD/511/Rev. 1, 8 August 1977.

4. Summary:
   The national self-supervision provision is very similar to that of the ENMOD Convention*. The consultation provision is considerably narrower in scope, however, lacking reference to consultation through appropriate international procedures within the framework of the UN or to services of appropriate international organizations. There is also no provision made for a Consultative Committee of Experts, or a review conference.

5. Selected Comments of States:
   One of the reasons given by the US (PV. 789, 11 May 1978) for rejecting the all encompassing approach to prohibiting new weapons of mass destruction (instead of individual agreements on specific new types of such weapons) was that if such a treaty were given the verification procedures necessary to make it more than an illusion, it could threaten to obstruct scientific development in areas where it would neither be necessary nor advisable.

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* See abstract M11(G77).

CHAPTER M

COMPLAINTS PROCEDURES

Arms control proposals frequently include special provisions for airing and resolving complaints. In this context it is possible to distinguish two types of complaints: those which relate to the general administration of the treaty and those which concern suspected violations. In the case of the former, the review conference or some similar forum would probably be the most appropriate body to consider the matter. In the case of the latter, some special mechanism is often seen to be necessary. It is this latter situation with which this chapter is concerned.

The treatment of complaints concerning alleged violations varies widely in a number of respects, making generalizations difficult. For example, proposals may differ as to the nature of mechanism they envisage, as well as the precise responsibilities assigned to the parties under the provision. Furthermore, the role assigned the complaints procedure itself within the verification system also differs from proposal to proposal. In some cases the complaints procedure is viewed as the means of initiating a verifying investigation, in others as a means of resolving continued uncertainty after previous verification techniques have suggested a violation and in still others as a means for ensuring punishment of a proven violator.

It is perhaps most useful to view the complaints procedure as an integral part of the verification system, though not itself a verification "technique". Verification techniques provide the evidence for the generation of complaints as well as their resolution. The complaints procedure concerns itself with the mechanism for dealing with this evidence and the questions which it may raise. The difficulty with many technical methods of monitoring events is that they frequently produce ambiguous results. Furthermore, while one party may be prepared to accept a certain level of proof, others may require stronger evidence. Consequently, it is necessary to establish some agreed procedure for determining the "facts" or at least a forum where differing interpretations of the "facts" can be aired. Moreover, in order to resolve a question over an alleged violation it may prove necessary that additional verification techniques be employed to generate more evidence. To acquire such additional information parties may have to agree on which methods are to be employed since these may not be already specified in the treaty.

Four basic types of complaints mechanisms can be distinguished. It should be noted that while these mechanisms may perform the function of dealing with complaints they may have other functions as well. Moreover, it should also be pointed out that a proposal for the establishment of a complaints procedure may involve the use of more than one of the mechanisms outlined below. Often such a proposal implicitly and sometimes explicitly, includes the idea of a series of mechanisms operating somewhat like an escalating response ladder.

1. Consultation and Cooperation

This procedure establishes the right of any party with a complaint to "consult" with any other party concerning the complaint and imposes on the other party the obligation to "cooperate" in resolving the problem.

2. Consultative Commissions

A consultative commission is a more formalized procedure for consultations between parties though it is still essentially similar to the consultation and cooperation formula especially in regard to the voluntary nature of the obligation to cooperate. It involves the creation of a committee of the parties which meets regularly and/or on request. Depending on the proposal, the parties are represented by diplomats and/or experts. Such a commission forms part of the SALT I Accords and the ABM Treaty of 1972, for which it seems to be functioning reasonably well.

3. Existing International Organizations

Referral of the complaint to an existing international organization may involve recourse for investigation to a specialized organ like the International Atomic Energy Agency, the World Health Organization, the United Nations Environment Program, or the International Court of Justice. It may also mean referral to a more general body like the UN Secretary General, the UN Security Council or some regional organization like the Organization of American States. A distinction is sometimes made between use of a general body to receive complaints and a specialized body to conduct the actual investigation.

4. New International Organizations

Creation of new international organizations to deal with complaints has also been proposed. A distinction can be made between proposals envisaging a specialized body usually to deal with complaints involved in only one treaty, and proposals concerning a general International Disarmament Organization whose jurisdiction would cover a number of treaties as well as a variety of functions.

Some form of complaints procedure is an important, indeed essential, part of any verification system. In certain cases states may consider it to be sufficient alone for providing assurance that violations will be deterred or if not deterred that innocent parties will have adequate warning to ensure their safety and a method of abrogating the treaty without incurring political blame. Complaints procedures can serve such a role when the arms control measure is not of great military significance as, for example, is the case with the BW Convention and the ENMOD Treaty. Where, however, the weapons systems and activities are more militarily important, where the consequences of a violation are more serious to innocent parties, it is likely that a complaints procedure alone would prove inadequate.

The ultimate sanction in most forms of complaints procedure is abrogation of the agreement. Such a sanction is not a step to be taken lightly because of the political onus which would rest on the party responsible for the breakdown of the agreement.

Another difficulty is that a complaints procedure relies on other verification measures to be triggered. As a result, the utility of the complaints procedure's deterrent effect on violators is heavily dependent on the triggering technique's efficiency in detecting a violation. When their sensitivity is low (e.g. economic records monitoring) or where they leave gaps on the range of events detectable (e.g. seismic monitoring) the complaints procedure's effectiveness will be similarly affected. One can not complain of a violation of which one does not know.

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Any arms control agreement	1
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M1(G71)

PROPOSAL ABSTRACT M1(G71)

1. Arms Control Problem:
   Chemical and biological weapons - destruction of stocks
   - production

2. Verification Type:
   a) Complaints procedure - consultation and cooperation
      - referral to Security Council
   b) On-site inspection - selective
   c) National self-supervision
   d) International exchange of information
   e) International control organization

3. Source:
   Sweden. "Working paper on a model for a comprehensive agreement concerning the prohibition of chemical and biological means of warfare". CCD/322, 16 March 1971.
   See also: CCD/PV. 499, 9 March 1971.
   CCD/324, 30 March 1971.

4. Summary:

Sweden proposes to classify the objects of the prohibition into three groups:

a) those agents with exclusively military use and which are supertoxic;
b) all remaining agents which have some legitimate industrial or medical application; and
c) ancillary equipment of vectors specifically designed for CB warfare.

Group "a" could be banned completely. Groups "b" and "c" could be banned conditionally.

The verification procedures would concentrate mainly on the agents. Suspicions of violations of the overall ban or corollary prohibitions would be handled within the framework of a detailed complaints procedure. The complaints procedure must take the form of a system of successive steps, including consultations between the parties and other fact-finding measures (e.g. "verification by challenge"). The final step would be referral to the Security Council.

Destruction and disposal of existing stocks of CBWs should be verified through an international procedure. The method of destruction must be easily observable and verifiable.

Verification of the prohibitions on the agents would be a combination of national and international measures. The most rigorous methods would deal with group "a" agents. Any deviation from the complete ban on production of these substances would have to be reported to an international agency, giving reasons for

the production. In the case of any large scale production (i.e. greater than one kilogram) or in the case of suspected undeclared production, the international agency might be entitled to carry out on-site inspection either at the invitation of the suspected party or on an obligatory basis.

Verification of group "b" and group "c" objects would be carried out by national menas only, perhaps complemented in some cases by statistical reporting by the parties to an international agency. National self-control might include international harmonization of basic national regulatory mechanisms as has happened in the narcotic drug field.

PROPOSAL ABSTRACT M2(G68)

1. Arms Control Problem:
   Biological weapons

2. Verification Type:
   Complaints procedure - referral to new international body
   - referral to Security Council

3. Source:
   United Kingdom. "Working paper on microbiological warfare". ENDC/231, 6 August 1968.
   See also: ENDC/PV. 387, 6 August 1968.
   ENDC/PV. 404, 17 April 1969.

4. Summary:

   The verification of a biological weapons convention cannot be accomplished by methods such as the safeguard provisions in the Non-Proliferation Treaty. This is so because the organisms used as BWs have medical and veterinary uses and could be produced quickly, cheaply and without special facilities, in either established or makeshift facilities.

   The most effective control provision for a BW treaty is a complaints procedure. ENDC/231 suggests that a competent body of experts, under UN auspices, be created to investigate allegations by any party to the convention which appeared to establish a prima facie case of a violation by another party. The parties would also be obliged to cooperate in any investigation.

In PV. 404, the complaints procedure is elaborated. The investigation must be prompt and it would need to have two distinct elements. First, machinery for receiving complaints and initiating an investigation would be required. Second, there would have to be machinery for carrying out the actual work of the investigation. These two functions need not be combined in the same body. Because of the need for speed in investigating complaints, the procedures would have to be automatic. All discovered facts would be sent to the Security Council which would decide on follow-up action.

PROPOSAL ABSTRACT M3(G72)

1. Arms Control Problem:
   Chemical weapons - production

2. Verification Type:
   a) Complaints procedure - consultation and cooperation
      - referral to Secretary General
      - referral to Security Council
   b) International control organization

3. Source:
   Japan. CCD/PV. 547, 7 March 1972.
   See also: CCD/PV. 594, 22 March 1973.

4. Summary:
   Japan reiterates its previous proposals concerning the use of gas chromatography and economic records monitoring as verification techniques.* A complaints procedure is also required. Complaints should be lodged with the Secretary General of the UN together with all available information, who would then conduct an investigation aided by an international panel of experts. The results would be reported to the Security Council.
   In PV. 594 Japan affirms the need for an international body to observe and control implementation and so obtain objective facts on any violation. Japan supports the Netherlands idea in this regard.** As a first step to such international control it would be helpful to establish a system for monitoring statistics of production, export, etc., of certain chemical substances. A bilateral consultation procedure should precede the activation of the UN complaints procedure.

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* See: abstracts B39(G70) and E1(G70).
** See abstract N3(G71).

PROPOSAL ABSTRACT M4(G69)

1. Arms Control Problem:
   Biological weapons - destruction of stocks
   - production
   - proliferation
   - research and development
   - stockpiling

2. Verification Type:
   Complaints procedure - referral to Secretary General
   - referral to Security Council

3. Source:
   United Kingdom. "Draft convention for the prohibition of biological methods of warfare and accompanying draft Security Council resolution". ENDC/255, 10 July 1969.
   See also: ENDC/255/Rev. 1, 25 August 1969.

4. Summary:
   Two complaints procedures were suggested:
   1) Article 3(1) provided for complaints about BW use to be sent to the Secretary General who would investigate immediately and report his findings to the Security Council.
   2) Other complaints, for example, concerning production, possession or use against another party would be addressed to the Security Council itself which could then authorize an investigation by the Secretary General.

   This distinction between investigation of use and investigation of production, etc., was justified on the grounds that in the case of use, the complainant would provide the facilities for carrying out the inquiry. Thus quick and automatic investigation would be possible. In the case of production, etc., it would be the accused party who would provide the facilities for investigation and the greater political weight of the Security Council would, therefore, have to be used. In this case the investigating body's function would be to establish the types and quantities of BWs that were in production and report the justification for that production by the state concerned. It would then be up to the Security Council and the individual parties to decide whether the justification was adequate or not and to act accordingly. In other words, there would still be a distinction between the fact-finding stage of the complaints procedure and the political decision stage even when the matter was brought directly

M4(G69)
M5(T72)

to the Security Council.

The draft convention was intended to supplement the Geneva Protocol of 1925. It was to prohibit use of BWs even in self-defence, by prohibiting research, production, possession and acquisition of BWs for hostile purposes though it did not seek to exclude purely defensive research or the creation of a passive defensive capability.

The British proposal also suggested a draft Security Council resolution which was to be complementary to the draft convention, authorizing the Security Council to establish the complaints machinery and providing as much assurance as possible that complaints would be investigated and the appropriate action taken.

PROPOSAL ABSTRACT M5(T72)

1. Arms Control Problem:
   Biological weapons - destruction of stocks
   - production
   - proliferation
   - stockpiling

2. Verification Type:
   a) Complaints procedure - consultation and cooperation (Article 5)
   - referral to Security Council (Article 6)
   b) National self-supervision (Article 4)
   c) Review conference (Article 12)

3. Source:
   Convention on the Prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction. (The Biological Weapons Convention).
   Signed: 10 April 1972.
   Entered into force: 25 March 1975.
   Number of parties as of 31 December 1979: 87.
   See also: - Socialist States. "Draft chemical weapons convention". CCD/361, 28 March 1972. (The verification provisions of this draft are identical to those of the BW Convention).

4. Summary:
   Article 4 requires parties to undertake "any necessary measures" to implement the treaty within their territory, in accordance with their constitutional procedures.

   The parties also undertake to consult and cooperate to resolve any problems arising with regard to the objectives or the implementation of the treaty (Article 5). This may occur "through appropriate international procedures within the framework of the

United Nations".

Complaints regarding breach of the treaty may be lodged with the Security Council (Article 6(1)). Evidence in support of the complaint should be included. Parties are also obligated to assist the Security Council in any investigation it may conduct (Article 6(2)).

5. Selected Comments of States:

Sweden (CD/PV. 29, 24 April 1979 and PV. 91, 10 July 1980). deplored the lack of any provision in the BW Convention of any practical mechanism of dealing with complaints such as a consultative committee. The UK shared a similar view (CD/PV. 97, 5 August 1980).

PROPOSAL ABSTRACT M6(I80)

1. Arms Control Problem:

Biological weapons - destruction of stocks
- production
- proliferation
- stockpiling

2. Verification Type:

a) Complaints procedure - consultation and cooperation
- consultative commission
- referral to Security Council

b) National self-supervision

c) Review conference

3. Source:

Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and Their Destruction. Final Document. Geneva: 1980. BWC/CONF.1/10.

4. Summary:

Article 4:

Regarding Article 4 which requires parties to undertake the necessary measures to implement the agreement, the review conference called upon parties which have not yet taken such measures to do so immediately. It also invited states which have enacted such measures to make available copies to the UN Centre for Disarmament for the purpose of consultation.

Article 5:

The Conference considered the provisions in Article 5 concerning consultation and cooperation to include the use of various international procedures which would make it possible to ensure effective and adequate implementation of the convention. Such procedures include the right of any party to request that a

M6(I80)
M7(G79)

consultative meeting of experts be convened. Noting the concerns and differing views regarding the adequacy of Article 5, the Conference felt it should be considered again at an appropriate time.

Article 6:

The Conference noted the importance of referral of complaints to the Security Council as provided in Article 6 and that no party had yet invoked this provision.

PROPOSAL ABSTRACT M7(G79)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - stockpiling

2. Verification Type:
   a) Complaints procedure - consultative commission
   - consultation and cooperation
   - referral to Security Council
   b) International exchange of information - declarations
   c) On-site inspection - selective
   - non-obligatory
   d) National self-supervision
   e) International control organization
   f) Review conference

3. Source:
   Poland. "Outline of a convention on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction: Working paper". CD/44, 26 July 1979.

4. Summary:

The outline suggests consideration be given to including provisions for declarations by parties to the CW convention. The declarations would deal with stocks of CWs, production facilities (after entry into force of the convention) and with plans for destruction or conversion of these stocks and facilities. Information could also be exchanged about the process of destruction.

"Control" would take the form of a combination of national and international procedures. The possibility of establishing national control organizations and their functions should also be considered as well as an undertaking not to interfere with the use of national means of control.

Another area of consideration should be consultation and cooperation in solving problems arising from application of the convention. This might include use of appropriate international procedures within the framework of the UN and other international organizations. The possibility of lodging complaints with the Security Council and cooperation in carrying out investigations is another suggested provision. Regarding a Consultative Commission, the functions and procedures of the body should be considered as well as a Preparatory Committee.

Another suggested provision concerns requests to other parties, in connection with suspected violations of the convention, for information or permission for on-site clarification of factual circumstances.

Finally, provisions for an amendment procedure including an annual review conference should be dealt with.

5. Selected Comments of States:

Czechoslovakia (CD/PV.44, 24 July 1979) agreed that the treaty should provide for the obligation to announce a time-table for the destruction of production facilities and of time-limits for supplying information on carrying out the destruction. It would also be useful to provide for the obligation to declare - after the treaty has been signed - stocked CWs, the time-table for their destruction and the time-limits for supplying information.

National control organs should concentrate on verifying the destruction of stocks, the observance of the production ban and complaints concerning violation of the treaty. International procedures should be applied mainly in the case of complaints of violations. The treaty should also provide for the establishment of an international consultative body of experts, which would collect data for the carrying out of national controls and organize an exchange of experience. A review of the implementation of the treaty at regular intervals is recommended, especially in the first period following the conclusion of the treaty when technical problems are expected to arise in connection to destruction of stocks and production plants.

M8(G80)

PROPOSAL ABSTRACT M8(G80)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - stockpiling

2. Verification Type:
   a) Complaints procedure - consultation and cooperation
   - consultative commission
   - referral to Security Council
   b) International exchange of information - declarations
   c) Remote sensors
   d) National self-supervision
   e) International control organization
   f) On-site inspection - selective

3. Source:
   United States/Union of Soviet Socialist Republics. "Joint US-USSR report on progress in the bilateral negotiations on the prohibition of chemical weapons". CD/112, 7 July 1980.
   See also: - "Joint USSR-United States report on progress in the bilateral negotiations on the prohibition of chemical weapons" CD/48, 7 August 1979.
   - USSR. CCD/PV.788, 9 May 1978.

4. Summary:

Both the USA and USSR agreed at an early stage of their negotiations (see CCD/PV.788) that in addition to a general purpose criterion for determining the scope of the treaty's prohibitions, a set of toxicity criteria would be employed. These toxicity criteria,in CD/112, were used to define "super-toxic lethal chemicals", "other lethal chemicals" and "other harmful chemicals". Different levels of prohibition and different methods of verification would be applied on the basis of these toxicity criteria and certain other provisions.

Both states have also agreed on the need for exchanges of information. First they have agreed that parties to the convention should make declarations, within thirty days of becoming parties, concerning their stockpiles of CWs and their means of producing these agents. Also, plans for destruction or diversion to permitted uses of declared stocks should be announced which should include information on volumes and timing. Plans for the destruction of relevant production facilities should be declared within a year prior to the commencement of the destruction.

In addition to declarations, the parties to the convention should exchange statements and notifications regarding progress in destroying or diverting (to permitted uses) stocks and means of production as well as concerning completion of the process.

The USA and USSR have also come to agree that verification should involve both international and national methods. Regarding the former, the two superpowers propose the creation of a Consultative Committee which could be convened by the depository of the convention or on request of any party. The Committee would have a secretariat which would carry out activities of the Committee between its meetings.

To ensure that this Committee can begin work immediately after the convention enters into force, the superpowers have agreed on the necessity for a preparatory committee upon signature of the convention.

The Committee would provide a forum where information could be exchanged between parties (eg. regarding super-toxic lethal chemicals, lethal chemicals and precursors which are produced, acquired and used for permitted purposes). The Committee might also serve as a forum where parties could request information of another party concerning possible violations of the convention.

Consultation and cooperation to resolve complaints concerning compliance with the treaty can take place bilaterally as well as in the Consultative Committee. A request for information can include a request for an on-site investigation though reasons must be given. A party receiving such a request may accept the on-site investigation or refuse, giving appropriate explanations. The USA and USSR have not yet agreed (see CD/112) whether on-site investigation together with other verification measures will constitute a verification system capable of providing adequate assurances or whether something more is needed. They have agreed that it is necessary to develop procedures for on-site visits regarding the rights and functions of inspectors and of the host state.

In addition to consultation and cooperation to resolve complaints, a party may also raise a suspected violation of the convention in the UN Security Council. Finally, the Consultative Commission upon the request of a party or of the Security Council may take steps to clarify the state of affairs.

Concerning national methods of verification the superpowers have agreed that national technical means of verification would be employed in a manner consistent with accepted principles of international law. Parties should not try to impede NTMs nor use deliberate concealment.

Regarding other national methods, each party must undertake to adopt appropriate internal measures, in accordance with its constitutional law and procedures, to prohibit and prevent any activity contrary to the convention.

5. Selected Comments of States:

Speaking on behalf of the USSR, the Soviet representative (CCD/PV.789, 11 May 1978) stated that the bilateral discussions of verification questions with the USA had convinced the Soviet side that a solution can be found on issues still outstanding which, while ensuring the reliable fulfilment of all the obligations assumed by parties to the convention would not infringe the sovereign rights of those states and would not lead to the disclosure of state or industrial secrets.

Japan (CCD/PV.801, August 17, 1978) stated that since the threshold to be applied to chemical agents to be banned and verification procedures for dual-purpose agents involve technical, specialized and complicated problems, every country is concerned over the strong possibility that such verification procedures may intrude upon its non-military chemical industry. It is therefore necessary for each country to closely examine any treaty's provisions in relation to its national laws. Hence even after the USA and USSR present their joint treaty to the CCD sufficient time will be needed to examine it.

In CD/PV.47 (2 August 1979) in response to the USA/USSR working paper (CD/48) Japan raised the question of whether data exchanged bilaterally by parties would be made available to all other parties to the convention. During the 1980 session (CD/PV.94, 24 July) Japan stated that the proposed convention should provide for systematic on-site inspections to verify at least the destruction of stocks and the destruction or dismantling of production facilities.

Several other states also referred to the need for on-site inspections. See: Australia (CD/PV.3, 25 January 1979), Italy (CD/PV.29, 24 April 1979), the FRG (CD/PV.29, 24 April 1979, and elsewhere), Egypt (CD/PV.31, 26 April 1979), France (CD/PV.43, 19 July 1979), Denmark (CD/PV.44, 24 July 1979), Pakistan (CD/PV.82, 19 April 1980) and Spain (PV.88, 1 July 1980).

Hungary (CD/PV.9, 8 February 1979), on the other hand, referred to the increasing demands for excessive on-site inspection or the establishment of international machinery for verification which might easily start a life independent from the actual disarmament agreements. Such pressure for absolute verification only serves to block negotiations. Bulgaria (CD/PV.93.17 July 1980) expressed a similar position claiming that emphasis on on-site inspection serves as a smokescreen to hide a lack of political will.

France (CD/PV.47, 2 August 1979) pointed to the fundamental inequality which exists among states regarding the possibilities of national means of verification. In some countries these are highly developed while in others they are much less so. This situation gives added importance to the problem of international verification. A similar sentiment was expressed by the representative of Spain (PV.88). Pakistan ('.82) called for international advisory and training services to assist developing states in building CW defenses. The convention should also provide equal and non-discriminatory access to information concerning verification to all parties. Pakistan was also critical of reliance on the Security Council for ensuring compliance in view of the inherent inequality entailed in the procedures of the Council.

PROPOSAL ABSTRACT M9(G75)

1. Arms Control Problem:
   Other weapons of mass destruction - environmental modification

2. Verification Type:
   a) Complaints procedure - consultation and cooperation (Article 5(1))
   - referral to Security Council (Article 5(2)) & 5(3))

3. Source:
   Union of Soviet Socialist Republics. "Draft convention on the prohibition of military or any other hostile use of environmental modification techniques", CCD/471 of 21 August 1975. An identical draft was simultaneously submitted by the United States (CCD/472).

4. Summary:
   Article 4 is almost identical to Article 4 of the previous Soviet draft ENMOD treaty.* It requires states to undertake "any neccessary measures" to prevent activity within their territory which is banned by the treaty. Article 5 includes provisions similar to that of Article 6 of the earlier USSR draft treaty, concerning referral of complaints to the Security Council and obligations to assist Security Council investigations. But Article 5 also includes, unlike the earlier USSR draft, a provision under which parties are obligated to consult and cooperate in resolving any problems in relation to the objectives or application to the treaty. Such consultation and cooperation may be undertaken "through appropriate international procedures within the framework of the United Nations".

   It should also be noted that the provision for a review conference of the earlier USSR draft convention has been dropped here.

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* See abstract L13(G74).

PROPOSAL ABSTRACT M10(G76)

1. Arms Control Problem:
   Other weapons of mass destruction - environmental modification.

2. Verification Type:
   a) Complaints procedure - consultative commission
      - referral to new international body
      - referral to Secretary General
   b) International control organization

3. Source:
   Netherlands. CCD/PV. 692, 9 March 1976.
   See also:
   - Federal Republic of Germany. PV. 697, 25 March 1976.
   - Sweden. PV. 697, 25 March 1976.
   - Australia. CCD/480, 24 February 1976.
   - Roumania. PV. 703, 20 April 1976.

4. Summary:

An intermediate body is needed to which to complain before the Security Council takes up a matter. Such a body might take a number of forms, including:

1) A general International Disarmament Organization along lines previously suggested by the Netherlands* and Sweden.**
2) The Secretary General of the UN might be given a fact-finding role with assistance from specialized bodies.
3) A committee of parties could be created whose function would be to assist the Secretary General in fact-finding. It would also prepare for the review conference. It could be composed of 10-15 states parties including those permanent members of the Security Council who are parties to the treaty; or it could be restricted only to members of the Security Council who are also parties to the treaty.

Similar ideas were presented by a number of other states in 1976 including the Federal Republic of Germany which called for a special verification committee to keep abreast of scientific and technological developments in the field and to perform a fact-finding function when a complaint arises including the use of on-site inspection.

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* See abstract N3(G71).

** See abstract N14(G73).

Sweden also suggested that there was a need for some sort of international machinery to ensure that objective verification procedures are available at an international level, citing the Netherlands' idea of the consultative committee. Sweden wanted more precise rules as to the procedures of consultation and cooperation, preferring a scheme which included a sequence of methods of inquiry, exchange of information and other verification methods culminating only in the final stage with referral of the complaint to the Security Council.

Australia called for a specific provision in the treaty giving specialized UN bodies advisory roles in the adjudication of complaints.

Roumania called for periodic conferences of the parties to be used as a forum for "collective verification" of the treaty. This would enable all states to have access to information and data thereby increasing their capability to detect possible violations.

PROPOSAL ABSTRACT M11(T77)

1. Arms Control Problem:
   Other weapons of mass destruction - environmental modification.

2. Verification Type:
   a) Complaints procedure
      - consultation and cooperation (Article 5(1))
      - consultative commission (Article 5(2) and ANNEX)
      - referral to Security Council (Article 5(3) and 5(4))
   b) National self-supervision (Article 4)
   c) International control organization
   d) Review conference (Article 8)

3. Source:
   Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques. (The ENMOD Convention).
   Signed: 18 May 1977.
   Entered into force: 5 October 1978.
   Number of parties as of 31 December 1979: 27.

4. Summary:
   It is important to appreciate the scope of the prohibition incorporated into this treaty. Each party under the treaty is banned from engaging in military or other hostile use of environmental modification techniques having widespread, long-lasting or severe effects.

M11(T77)
M12(G79)

With regard to the verification provisions Article 4 of the convention remains essentially unchanged from the earlier US USSR draft treaty*, though Article 5 has been altered substantially. As in the earlier draft, Article 5 provides for consultation and cooperation either between the parties themselves or through appropriate international procedures. However, the scope of these international procedures has been clarified to include the possibility of fact-finding by existing international organs, like the World Meterological Organization or the United Nations Environment Program, and the assistance of the Consultative Committee of Experts established under Article 5(2). The Consultative Committee of experts is prevented from dealing with controversial matters which are to be left to Security Council.
The annex to the Treaty defines the functions and rules of procedure of this Consultative Committee.

A state, thus, has a range of actions with regard to any complaint it may have. The state itself decides which of these courses to pursue.

PROPOSAL ABSTRACT M12(G79)

1. Arms Control Problem:
   Other weapons of mass destruction - radiological weapons
2. Verification Type:
   a) Complaints procedure - consultation and cooperation (Article 8 (1))
      - consultative commission (Article 8 (2) and Annex)
      - referral to Security Council (Article 8 (3) and (4))
   b) National self-supervision (Article 6)
   c) Review Conference (Article 11)
3. Source:
   Union of Soviet Socialist Republics. "Agreed joint USSR-United States proposal on major elements of a treaty prohibiting the development, production, stockpiling and use of radiological weapons". CD/31, 9 July 1979. The US submitted an identical working paper (CD/32) on the same day.
4. Summary:
   According to this draft treaty, parties undertake to consult and cooperate to solve any problems arising concerning the objectives or application of the treaty. (Article 8 (1)). This may be done through appropriate international procedures within the framework of the UN.

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* See abstract M9(G75).

These international procedures may include the services of appropriate international bodies as well as the Consultative Committee of Experts.

The Consultative Committee will be convened by the Depository (i.e. the UN Secretary General) within a month from the receipt of a request from any party. The Committee will report to the Depository a summary of its findings of fact, incorporating all views presented during its proceedings (Article 8 (2)). The Depository or his representative will serve as the chairman of the Committee. Experts on the Committee will have the right to request from states and international organizations information and assistance. Procedural matters will be settled by consensus, whenever possible, or by majority vote. There will be no voting on matters of substance (Annex).

Any party may lodge a complaint, together with all relevant information regarding breach of the treaty, with the Security Council (Article 8 (3)). Parties undertake to cooperate with any Security Council investigation. The Council will inform parties of the results of the investigation (Article 8 (4)).

Article 6, similar to a provision in the ENMOD Convention*, requires parties to undertake any necessary measures to prevent loss or diversion of radioactive materials within their territory.

5. Selected Comments of States:

Several states were unhappy with the verification system outlined in the USA/USSR draft treaty. Sweden felt that IAEA safeguards might be preferable to a system of national control of radioactive wastes and that recourse to the Security Council with complaints was undesirable because of the permanent members veto power. See also: Egypt (CD/PV.77, 10 April 1980) and Pakistan (CD/PV.77). Sweden also preferred a review conference within five years instead of ten as specified in the draft (CD/PV.63, 26 February 1980).

Belgium was concerned that the procedure for convening the Consultative Committee was too slow. Belgium also questioned whether the Depository would have the power to investigate before convening the Committee. Furthermore, the Committee should have the power to deal with problems other than those raised by the party requesting its meeting (CD/PV.76, 9 April 1980).

Japan requested elaboration on several points concerning Article 8 (CD/PV.80, 22 April 1980). Both Italy (CD/PV.42, 17 July 1979) and the Netherlands (CD/PV.76) believed that the verification system in this treaty should not be a precedent for future arms control agreements.

* See abstract M11(G77).

M13(I80)

PROPOSAL ABSTRACT M13(I80)

1. Arms Control Problem:
   Regional disarmament

2. Verification Type:
   a) Complaints procedure
   b) On-site inspection - control posts
   c) Remote sensors

3. Source:
   United Nations. Secretary General. "Study on All the Aspects of Regional Disarmament: Report of the Secretary General". 8 October 1980.

4. Summary:

Verification is important in a regional disarmament context. The form and modalities depend on the purposes, scope and nature of the disarmament measure in question as well as on regional peculiarities. Consideration of verification measures should include the establishment of regional consultation and verification mechanisms or agencies and the role that UN organs will play. Regional measures for verification can be combined with broader international mechanisms.

Other possible verification means include the installation on a reciprocal basis of stationary and/or mobile observation posts, joint or reciptrocal air or satellite observation of given areas, or mutual understandings not to impede the use of national technical means of observation.

PROPOSAL ABSTRACT M14(A77)

1. Arms Control Problem:
   Any arms control problem

2. Verification Type:
   a) Complaints procedure - consultative commission
   b) International exchange of information

3. Source:
   Agnew, H.M. "A Plan to Lessen Suspicions", Bulletin of the Atomic Scientists 33, no. 3 (March 1977): 6-7.

4. Summary:

According to the author, the basic problem in American-Soviet relations stems from the closed nature of Soviet society. Until the West and the East develop a mechanism which allows each side to overcome the suspicions which arise from this secrecy the US and USSR will continue to live under unsettling conditions.

Agnew makes two proposals to improve the situation. First, the Soviets must be more forthcoming concerning information on their military capabilities. Second, he proposes that the superpowers "consider establishing a system to avoid misunderstanding in verifying future arms control agreements". A hypothetical example of such misunderstanding might be the detection by the US of a Russian "death ray" production center which in reality is a colour TV production plant. The evidence of the existence of a Soviet "death ray" centre could be used by American defence officials to support the development of an American "death ray". When the Americans begin developing such a weapon as a result of the perceived Soviet threat, the Soviet Union learns of this activity and starts its own "death ray" project.

In order to avert such problems, a procedure might be established which enables each side to bring to the attention of the other, certain facts which cause alarm. The suspected party would be requested to provide an explanation of the information supplied.

The system could be structured like the jury selection process in domestic law. In jury selection each party can reject a certain number of potential "jurors", but a fixed number of "jurors" must be chosen from a finite number of candidates. In an analogous fashion, every three or six months the US and USSR would bring twelve different facts for discussion at a closed meeting. Each fact would be presented in the form of photographs, items of hardware or intercepted messages.

M14(A77)

It would be agreed that each nation could on a case by case basis, accept or reject a fact for discussion but that it would have to accept, for example, six of the twelve "facts" for discussion and explanation before the selection period was over. Acceptance or rejection would be decided in the order in which the facts were presented. Neither side would be presented with the total package and then simply allowed to choose six. For each fact accepted for discussion, the accepting nation would be required to describe what the photograph, piece of hardware or message was all about.

Initially, the nation receiving the information could only listen. No challenge, rebuttal or further questioning would be allowed at the time of presentation. However, since the information received could then be evaluated, related decisions it is hoped, would then be based on less uncertain data than we base them on today. Obviously, there is likely to be dissembling in the replies. But the incentives for candor, and the risks of cheating should also be obvious.

This system is just one of many possibilities. Such a system of information exchange would be a major step toward lessened mistrust between the superpowers. Furthermore, in light of the disparities between the two societies, "in the absence of such an information exchange there is a danger that the results of agreements such as those which have been concluded in the recent past may be slanted in the Soviet favor. Over the long term, the aggregate of such seemingly small advantages could create an overall US - Soviet position which would indeed threaten US national security".

CHAPTER N

INTERNATIONAL CONTROL ORGANIZATIONS

International control bodies can be intended either to deal generally with a number of arms control matters or their scope can be limited to a ingle measure. A problem with the former course is that it involves supervising a number of arms control agreements each with its own set of parties.

A wide variety of functions for an international control body have been envisaged. Proposals differ considerably as to which they include. For the purpose of description, however, it is possible to suggest a simple scale in terms of the degree of responsibility assigned the international organ in a proposal.

At the lowest end of this scale are organs with the function of receiving reports from parties, perhaps compiling a summary report, and then distributing the information to the parties. Much higher on the scale would be assigning the international agency the function of analyzing, independently of the parties, the information it receives. In effect, this would amount to giving the international body independent political judgement by permitting it to come to conclusions about whether a suspicious event had occurred.

Another function related to the previous one which also ranks high on the scale, is that of responsibility for conducting or delegating the conduct of verification techniques such as literature surveillance, on-site inspection and even remote surveillance by satellite.

Also fairly high on the scale is the function of conducting investigations as part of a complaints procedure. Investigations could be conducted only on request or they might be undertaken on the initiative of the international control body itself. In the latter case the degree of responsibility assigned the international organ is considerably greater.

The role of supervising national regulatory mechanisms is another function which might be given an international control body and which ranks high on the scale. Related to this is the duty of checking on the credibility of data received in international exchanges.

A function which lies lower on the scale is that of advising the parties. In this regard, international boards of scientific experts of such matters as the capabilities of various verification techniques; the weight of the technical evidence concerning a possible violation, or the sorts of chemical substances to be added to a list of banned substances under a CW convention.

Two other duties which might be undertaken by the international agency are organizing the review conference, and providing that body with an evaluation of the verification system. These functions would rank relatively low in the scale of responsibility.

Some clear patterns emerge concerning reactions to proposals involving international control organs. To begin with, the greater the degree of responsibility with regard to the verification system assigned to the international body (i.e. the higher it ranks on the scale mentioned above), the greater is the resistance it faces from some states, particularly the superpowers. Another clear pattern is that the wider the scope of the proposed international organ (i.e. the greater the number of arms control agreements with which it is to deal) then the greater the resistance of states.

To counter this resistance it can be argued that an international control agency, especially one with wide responsibilities is a basic goal for arms control and disarmament. It would give a greater role in arms control to the less powerful but often populous Less Developed Countries which do not at present have the capability to employ modern verification techniques on their own. An international body might also be expected to show greater impartiality as compared to national systems and to carry more weight in a positive sense for arms control measures. For regional or other arms control agreements where the major powers are less directly involved creation of international bodies with a specific verification role has sometimes proved to be feasible.

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PROPOSAL ABSTRACT N1(G61)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) International control organization
   b) On-site inspection - selective
      - control posts
   c) Seismic sensors
   d) Short-range sensors - sampling
   e) Remote sensors - satellites
      - sampling
      - aerial

3. Source:
   United Kingdom and United States. "Draft treaty on the discontinuance of nuclear weapon tests". ENDC/9, 21 March 1962. (Originally GEN/DNT/110, 18 April 1961).
   See also: "Draft treaty banning nuclear weapon tests in all environments". ENDC/58, 27 August 1962, abstract N2(G62)

4. Summary:
   A Control Organization (CO) is to be set up to assure parties that obligations under the treaty are being carried out. Parties are obligated to cooperate promptly and fully with this body. The CO will consist of a Control Commission, a Detection and Identification System, a Chief Executive Officer and a Conference of the Parties (Articles 2 and 3). The bulk of this draft treaty is composed of very detailed provisions relating to this Control Organization.
   The Commission will be composed of three permanent members (UK, US, USSR) plus six non-permanent members elected for two years (Article 4). The Commission will have the following functions (Article 6):
   1) establishment of procedures and standards for the operation and installation of the Detection System,
   2) appointment of the Chief Executive Officer,
   3) approval of deputy administrators,
   4) establishment of procedures for disseminating data, produced by the detection system,
   5) reporting to the Conference,
   6) deciding on location of elements of the Detection System,
   7) deciding on permanent flight routes for overflights by aircraft sampling missions,
   8) conclusion of agreements with states to aid in carrying out treaty provisions,
   9) ensuring research and development into detection methods,
   10) establishment of procedures for conduct of PNEs and

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11) periodic review of the detection system (Article 14).
Decisions are to be made by simple majority vote.

The Conference will meet regularly or upon request. Most matters will be decided by simple majority votes. The functions of the Conference include (Article 8):

1) election of non-permanent members of the Commission,
2) approval of reports and budget submitted by the Commission,
3) approval of reports to the UN,
4) approval of agreements between the CO and other bodies and
5) approval of amendments to the treaty.

The Chief Executive Officer will be responsible to the Commission. He will appoint, organize and direct staff except as specifically provided in the draft treaty. Staff will be recruited on as wide a geographic basis as possible, from personnel acceptable to the governments of the countries from which they come. Certain exceptions are provided to this rule of geographic recruitment mainly relating to balance among UK, US and USSR personnel in some situations and composition of inspection teams. The Chief Executive Office will also prepare the budget of the CO, develop an R and D program concerning detection technology and recommend details for setting up the Detection System (Article 9). The Administrator will also designate by public notice seismic events eligible for on-site inspection. He will send inspection teams if certain conditions are met (see Article 10). A maximum of 20 inspections may be conducted per year on the territory of an original party.

The treaty also provides in detail what is expected of parties in the way of cooperation with the CO (Articles 11 and 12). Special provisions are also made for the conducting and monitoring of PNES (Article 13). Details as to financing of the CO and privileges and immunities of its staff are given as well (Articles 15 and 16).

The Detection and Identification System is outlined at length in Annex I of the draft treaty. It is composed of a headquarters, regional offices, land control posts and ship-based control posts, systems of satellites, radiochemistry laboratories, air and water sampling facilities, on-site inspection facilities and communications facilities. Air sampling will be conducted by aircraft. Criteria for on-site inspection are spelled out in great detail (see Articles 8 and 9 of Annex I) as are other elements of the system.

Annex II outlines the Privileges and Immunities to be accorded CO personnel. A Preparatory Commission is described in Annex III which will come into existence when the treaty is signed with the goal of setting up the CO.

PROPOSAL ABSTRACT N2(G62)

1. Arms Control Problem:
   Nuclear weapons - comprehensive test ban

2. Verification Type:
   a) International control organization
   b) On-site inspection - selective
      - obligatory
   c) Seismic sensors
   d) Remote sensors - satellite
      - shipborne

3. Source:
   United Kingdom and United States. "Draft treaty banning nuclear weapon tests in all environments". ENDC/58, 27 August 1962.
   See also: "Draft treaty on the discontinuance of nuclear weapon tests". ENDC/9, 21 March 1962, abstract N2(G62).

4. Summary:
   An International Scientific Commission will be set up to verify compliance with the treaty. The Commission will include an International Staff and a Verification System. Parties would be obligated to cooperate with the Commission (Article 2).
   Article 3 outlines the functions of the Commission which include:
   1) collecting and reporting data on suspicious seismic events and identifying such events,
   2) supervising the Verification System,
   3) consulting with parties to determine the nature of an event,
   4) aprroving the annual budget,
   5) arranging inspections,
   6) establishing such laboratories and facilities as are needed,
   7) appointing an Executive Officer,
   8) conducting research to improve verification technology, and
   9) arranging conferences of the parties.

   The organization and procedures of the Commission are detailed in Article 4. It will be composed of fifteen members of which three will be permanent members (UK, USA and USSR). The other members will be determined by a formula intended to maintain a geographic balance of members. Terms for non-permanent members will be three years. Decisions will be by majority vote unless otherwise specified. The Commission will meet when it decides it to be warranted or upon the request of any party. Parties not members of the Commission may participate at its meetings.
   The functions and organization of the International Staff are detailed in Articles 5 and 6. Functions include supervising the

collection of data and its analysis as well as manning of the Verification System. An Executive Officer will recruit, organize and oversee the staff which will include qualified scientific and technical personnel.

The Verification System is discussed in Article 7. It is intended to provide rapid and reliable collection and reporting of data. The following "classes" of stations will be included:

1) Stations manned by nationals of the state in which they are located. Observers will be present at these stations.
2) Existing stations to be maintained and manned by individual parties.
3) Stations to be manned by Commission personnel.
4) Detection equipment located in space, the atmosphere or beneath the sea manned by the Commission or by the parties, as the Commission decides.

Existing stations are to be in operation within six months of the entry into force of the agreement while the newer stations are to be in operation within a year. The general equipment of these stations is listed.

Article 8 describes provisions for on-site inspection. Procedures and criteria for locating and identifying a seismic event are spelled out in general. Data from stations located on the territory of an event can not be used to render the event ineligible for inspection. The Executive Officer will designate suspicous events requiring investigation according to the criteria outlined. An inspection may be carried out on the territory of the UK or US if the USSR requests it or vice versa. Inspections on the territory of any other party may be conducted if the Commission so directs. A maximum number of inspections each year is to be decided upon. The number of inspections on the territory of permanent members is further restricted. Inspection teams will be organized by the Executive Officer and they are to have undisputed and immediate access to the area designated as the location of the event.

The Commission will annually review the Treaty and the operations of the Verification System and make reports to the parties (Article 11). Finances are dealt with in Article 12; privileges and immunities in Article 14.

PROPOSAL ABSTRACT N3(G71)

1. Arms Control Problem:
   a) Chemical weapons - production
   b) Any arms control agreement

2. Verification Type:
   a) International control organization
   b) Complaints procedure - consultative commission
      - referral to new international body
      - referral to Security Council

3. Source:
   Netherlands. CCD/PV. 502, 18 March 1971.
   See also: - PV. 560, 27 April 1972.
   - CCD/410, 31 July 1973.
   - PV. 617, 31 July 1973.
   - CCD/565, 30 March 1978.
   - PV. 783, 30 March 1978.
   - PV. 799, 10 August 1978.

4. Summary:

A complaints procedure should consist of two stages;

1) factual investigation by a body of experts or some international organ, and
2) only thereafter, at the discretion of the complainant, referral to the Security Council on the strength of the finding of the international organ or body of experts.

The Netherlands intention in taking this approach is to separate the functions of investigation and political judgement. This would avoid complaints becoming too political and incriminating at an early stage.

In PV. 560 the Netherlands makes reference to provisions for a consultative committee and to existing treaties such as the Tlatelolco Treaty and the Non-Proliferation Treaty. Such an international verification body might serve as a nucleus for a general international disarmament organ which in due course could take over responsibilities in other arms control fields.

The Netherlands elaborates in CCD/410 on its proposal for creation of a standing organ to support a CW convention. The organ would be composed of a plenary Conference, a Board, and a Secretariat headed by an Administrator. Its functions would include the following:

1) updating the list of prescribed chemical substances;
2) providing a clearing house for information exchange of various types;

3) receiving declarations and reports of various types from the parties;
4) providing observers for stockpile destruction;
5) conducting inquiries for supplementary information from parties;
6) conducting random checks; and
7) conducting special investigations.

The Conference might consider the results of any investigations, make recommendations to the parties and submit reports to the Security Council of the UN. If such an international organ existed there would be no need for a review conference.

In CCD/565 the Netherlands introduces a very similar proposal concerning an International Disarmament Agency. Such a body is desirable because there is a need for a permament organization to streamline consultations and implement measures as the number of complex multilateral arms control treaties increases. The new agency would at first be entrusted only with the verification of a CW treaty. However, it would be intended from the beginning that such an organ would take on other tasks, such as the verification of other agreements. Ultimately the agency would become the operational framework for the implementation of international arms control and disarmament agreements with functions mainly in the field of verification. In addition, the Agency would be instrumental in the preparation and organization of review conferences already provided for in several disarmament treaties and could serve, as well, as a clearing house for information on disarmament. The structure of the Agency would be similar to that described in CCD/410.

To realize this organ, the Netherlands proposes first that the UN Secretary General seek the views of UN member states on the functions and structure of the proposed Agency. To this end, the Netherlands suggests that a paragraph be added to the final document of the Special Session on Disarmament. Once replies had been received, a committee could be created to negotiate on the structure and function of the Agency.

PROPOSAL ABSTRACT N4(G79)

1. Arms Control Problem:
   Chemical weapons - destruction of stocks
   - production
   - stockpiling

2. Verification Type:
   a) International control organization
   b) On-site inspection - selective
   c) Short-range sensors - sampling

3. Source:
   Egypt. CD/PV.31, 26 April 1979.

4. Summary:

Compliance with any convention is largely dependent upon the verification methods employed. To be of value the convention must provide a limited degree of assurance to all parties that their compliance with it will not lead to diminished security and that other parties will equally comply with the convention.

Egypt encourages national verification measures including unilateral declarations concerning destruction of stockpiles, national legislation and regulation aimed at implementing the ban, and establishment of a national verification system to coordinate activities with an equivalent international body. However, the national security of parties makes it imperative that verification be universally non-discriminatory in nature and international in application. Only a qualified international verification organ can coordinate national and international verification measures. Only such an organ can be universal and non-discriminatory provided it is given the necessary degree of independence.

Extraterritorial monitoring techniques are only effective in verifying declared intentions related to known chemical plants or unclassified stockpiles or capabilities. These techniques alone cannot guarantee that a prohibition of the development and production of CWs is being complied with. On-site inspection remains the most effective and applicable verification measure capable of providing assurances to parties. The recent UK and FRG workshops* have shown that on-site inspections can be employed without sacrificing industrial secrets. Future workshops should encourage development of techniques that allow inspectors to take samples and photographs.

Verification measures should encompass non-organophosphorous agents as well as organophosphorous ones. Binary agents should also be covered.

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* See: abstracts B54(G79) and B41(G79).

N5(G80)

PROPOSAL ABSTRACT N5(G80)

1. Arms Control Problem:
   Chemical weapons - destruction of facilities
   - destruction of stocks
   - production
   - stockpiling

2. Verification Type:
   a) International control organization
   b) International exchange of information
   c) Complaints procedure - referral to new international body

3. Source:
   China. "Chinese delegation's proposals on the main contents of a convention on the prohibition of chemical weapons". CD/102, 19 June 1980.
   See also: CD/PV.89, 3 July 1980.

4. Summary:

The Chinese delegation contends that, in order to facilitate verification, stocks and production plants should be destroyed rather than shut down or converted to peaceful uses.

After entry into force of the convention, the parties should, within a specified time, disclose information pertaining to the numbers and locations of CW stocks and production facilities, as well as give a timetable for their destruction.

Stringent and effective measures of international control and supervision should be employed. An international control organ should be created to verify the destruction of CW stocks and plants. It should also be empowered to investigate charges concerning the use of CWs and other violations of the convention. In PV.89 China claims that such an international verification body is necessary in view of the disparity between countries in verification techniques and devices. It should possess qualified experts and advanced verification technology to permit it to discharge its function.

PROPOSAL ABSTRACT N6(A76)

1. Arms Control Problem:
   Regional arms control

2. Verification Type:
   International control organization

3. Source:
   Nutt, Anita L. Troika on Trial: Control or Compromise. Santa Monica, Calif.: September 1976. 3 volumes. NTIS AD 822 538.

4. Summary:
   The focus of the paper is on the control machinery employed to monitor the peace agreements of 1954 concerning Indochina, specifically the International Control Commission. Description of the mechanisms and a history of their implementation is provided. The author attempts to generalize her findings to observations on the use of the troika format (i.e. one representative from each of the East, the West and the non-aligned states) in other arms control contexts. She concludes that there are severe dangers to the use of the troika from the point of view of effective control.

PROPOSAL ABSTRACT N7(G80)

1. Arms Control Problem:
   Conventional weapons - aircraft
   - ground forces
   - ships

2. Verification Type:
   International control organization

3. Source:
   Italy. "Working paper: Control and limitation of international arms transfers". CD/56, 5 February 1980.

4. Summary:
   Italy advocates setting up, within the UN, an *ad hoc* body to monitor, control and limit, through agreed procedures, the international arms trade. This body should be structured into a number of regional Committees, corresponding to the areas taken into consideration for transfer restraints, which would include all major arms suppliers and recipients of the region.

   A General Conference within this *ad hoc* body should:
   - shape general guidelines for control and limitation arrangements,
   - elaborate legal, technical and military criteria for

achievement of such arrangements,
- control effective compliance with agreed arrangements, and
- keep a register of transactions.

Specific arrangements concerning different areas should then be worked out within the framework of the regional Committees.

PROPOSAL ABSTRACT N8(G61)

1. Arms Control Problem:
   General and complete disarmament
2. Verification Type:
   a) International control organization
   b) On-site inspection
3. Source:
   Union of Soviet Socialist Republics and United States. "Joint statement of agreed principles for disarmament negotiations". ENDC/5, 19 March 1962 (Originally A/4879, 20 September 1961).
   See also: "Working draft of Part I of the Treaty on general and complete disarmament (in a peaceful world) proposed by the USA and USSR". ENDC/40/Rev.1, 31 May 1962.
4. Summary:
   All disarmament measures should be implemented from beginning to end under strict and effective international control. During and after GCD the most thorough control should be exercised, the nature and extent of such control depending on the particular disarmament measures involved. To implement control and inspection, an International Disarmament Organization should be created within the framework of the UN. IDO inspectors should be assured unrestricted access without veto to all places as necessary for the purpose of effective verification.

   In Annexes to ENDC/5 letters exchanged between the US and Soviet representatives are reproduced. The American letter indicates that it is "a key element in the US position" regarding verification that whenever an agreement stipulates that a certain level of forces may be retained, the verification machinery must have all the rights and powers necessary to ensure that those levels are not exceeded.

   The response of the Soviet representative indicated that while favouring thorough and strict international control over GCD measures, the USSR is resolutely opposed to control of armaments retained at any given stage of disarmament. Such control would turn into an international system of legalized espionage.

PROPOSAL ABSTRACT N9(G62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) International control organization
   b) On-site inspection - general
      - obligatory
   c) Records monitoring - economic
   d) Remote sensors - aerial
   e) International exchange of information - declarations
      - reports to international body
   f) Complaints procedure - referral to Security Council

3. Source:
   Union of Soviet Socialist Republics. "Treaty on general and complete disarmament under strict international control". ENDC/2, 19 March 1962 and ENDC/2/Rev.1, 26 November 1962.
   See also: - "Memorandum of the government of the Union of Soviet Socialist Republics on disarmament negotiations in the Eighteen Nation Committee". ENDC/3, 19 March 1962.
   - Union of Soviet Socialist Republics and United States. "Working draft of Part I of the Treaty on general and complete disarmament (in a peaceful world) proposed by the USA and USSR". ENDC/40/Rev.1, 31 May 1962.

4. Summary:

Article 2 of the draft treaty requires that each disarmament measure incorporated into the treaty be accompanied by such control measures "as are necessary for verification". To implement control, an International Disarmament Organization (IDO) composed of all parties to the treaty, will be established within the framework of the UN, to begin operations as soon as the disarmament measures are initiated. The IDO is to have its own staff, recruited internationally, who will be present in all the countries party to the treaty. Representation on the IDO staff will be balanced between the western, eastern and non-aligned blocs. The IDO staff will exercise control over compliance on a temporary or permanent basis depending on the disarmament measure involved. Parties are obligated to submit to the IDO "in good time" such information about their armed forces, military production and military appropriations as is necessary to carry out the disarmament measures of the stage concerned. When the program of GCD is complete the IDO will continue to supervise compliance to prevent rearmament.

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Part V of the draft treaty outlines the structure and functions of the IDO in more detail. Generally, the IDO will deal with questions "pertaining to the supervision of compliance", while "questions connected with the safeguarding of international peace and security ... including preventive and enforcement measures, shall be decided upon by the Security Council".

The IDO will consist of a Conference of parties and a Control Council. The Conference will hold regular sessions at least once a year and special sessions upon request of the Council or a majority of parties. Each party will have one vote. Procedural questions will be decided by simple majority; other matters by a two-thirds majority. Functions of the Conference include:

1) electing non-permanent members of the Council,
2) examining reports of the Council,
3) approving the budget, and reports to other UN bodies,
4) approving amendments to the treaty, and
5) proposing matters for consideration by the Council.

The Control Council is to consist of the five permanent members of the Security Council and a number of non-permanent members elected for a period of two years. Representation on the Council is to be balanced between "the three principal groups of states existing in the world". Voting procedures will be the same as for the Conference; the permanent members will not have any veto power.

Functions of the Council include:

1) directing measures of control,
2) establishing staff organizations to carry out IDO functions,
3) devising rules, regulations and instructions for control,
4) submitting reports to the Conference,
5) remaining in constant touch with the Security Council and promptly notifying it of any violations,
6) reviewing results of the implementation of the treaty upon completion of each of the stages of GCD,
7) recruiting staff from among those recommended by parties,
8) preparing the budget of IDO, and
9) requesting from parties such information on their military as may be needed for control.

The IDO's personnel will enjoy the privileges and immunities necessary to exercise "independent and unrestricted control over implementation of the treaty". Financing of the IDO will come from the parties to the treaty according to a scale to be decided. Immediately after the treaty is signed a preparatory committee will be created to set up the IDO.

The disarmament measures to be undertaken are broken down into three stages by the treaty, each of which involves the elimination of several categories of forces. The role of the IDO in verifying these measures is stated in each of the sections of the treaty. The means by which the IDO will do this are primarily general on-site inspection*, and the analysis of budget, production and other

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* It is not clear whether on-site inspection will be general or selective in the first two stages of GCD. It will be general in the third stage, however.

records. In the third stage of disarmament the IDO will have the right to institute a system of aerial inspection over the territories of the parties.

In ENDC/3 the Soviet Union emphasizes that strict and reliable international control is an essential guarantee and an indispensable condition for the successful implementation of GCD. The IDO, however, cannot be trusted with any functions involving the execution of preventive or enforcement measures in regard to the States. This is the duty of the Security Council. The business of the IDO is to establish facts.

The IDO will supervise only reductions in forces not the levels of armed forces retained by parties at any given stage. The USSR rejects the contention that there can be no certainty that states are honouring their disarmament obligations if only reductions are verified. It is in the third and final stage when all armaments are destroyed that control will become unrestricted and comprehensive.

PROPOSAL ABSTRACT M10(G62)

1. Arms Control Problem:
   General and complete disarmament

2. Verification Type:
   a) International control organization
   b) On-site inspection - selective
      - progressive/zonal
      - control posts
   c) Remote sensors - aerial
   d) International exchange of information - declarations
      - reports to international body

3. Source:
   United States. "Outline of basic provisions of a treaty on general and complete disarmament in a peaceful world". ENDC/30, 18 April 1962.
   See also: - "Declaration on disarmament: A programme for general and complete disarmament in a peaceful world". ENDC/6, 19 March 1962.
   - Union of Soviet Socialist Republics and United States. "Working draft of Part I of the Treaty on general and complete disarmament (in a peaceful world) proposed by the USA and USSR". ENDC/40/Rev.1, 31 May 1962.

4. Summary:
   An International Disarmament Organization (IDO) would be created during stage I of the GCD process upon entry into force of the treaty. It would constitute the main vehicle for verification

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and would function within the framework of the UN. The IDO is described in section "g" under stage I of the American paper.

Verification functions of the IDO would be undertaken on the basis of several principles including the following:

1) Reduction measures including destruction would be verified at agreed depots or other locations.
2) Production, testing and other activities would be verified by the IDO which would have access to declared facilities wherever located.
3) Assurance that agreed levels of forces were not exceeded would be provided by the IDO through agreed arrangements which would have the effect of providing that the extent of inspection during any stage was related to the amount of disarmament undertaken and the risk posed to the parties. The US paper suggests as an example of such an arrangement a progressive/zonal inspection scheme. According to this scheme, each party would divide its territory into a number of zones and at the beginning of each step of the disarmament process would submit to the IDO information regarding total force levels within each zone. The exact location of the armaments would not be revealed prior to the selection of zones for inspection. An agreed number of zones would be progressively inspected by the IDO during Stage I, according to an agreed time schedule. Selection procedures would ensure that the party being inspected did not select the zones to be inspected. Upon selection of the zones, the party being inspected would declare the location of forces within each selected zone. Arrangements would ensure that no undeclared movements of armaments to or from the zone took place. Both aerial and mobile ground inspection would be used. Access within the zone would be free and unimpeded. Once a zone had been inspected it would remain open for inspection as additional zones were selected at later stages of the GCD process. By the end of Stage III all the zones will have been inspected.

The IDO would be composed of a General Conference of the parties, a Control Council of permanent and non-permanent members, and an Administrator. Expert study groups could be established by either the Conference or the Council.

The General Conference would have the following functions among others:

1) electing non-permanent members of the Council,
2) appointing the Administrator,
3) approving the budget,
4) requesting and receiving Council reports,
5) approving reports to the UN,
6) requesting advisory opinions from the International Court of Justice, and
7) approving amendments to the treaty.

The functions of the Control Council would include:

1) recommending for appointment the Administrator,
2) adopting rules for implementing the treaty,
3) establishing procedures and standards for the installation

and operation of verification arrangements,
4) establishing procedures for dissemination of data to parties,
5) considering reports from the Administrator,
6) requesting advisory opinions of the International Court of Justice, and
7) deciding whether each stage in the disarmament process had been satisfactorily completed.

The Administrator would have the following functions, among others:
1) administering the installation and operation of the verification arrangements,
2) providing data to the parties,
3) preparing the budget,
4) making reports to the Council on the progress of disarmament measures and their verification.

The privileges and immunities of the IDO personnel would be outlined in an annex to the treaty. Finance of the IDO would be borne by the parties according to an agreed scale of contributions. Disputes which could not be settled by negotiation or by the IDO itself would be referred to the International Court of Justice unless another mode was agreed to by the parties.

A United Nations Peace Observation Corps would also be established, members of which could be dispatched promptly to investigate any situation which might constitute a threat to the peace. Such a body could conceivably play a role in monitoring arms control obligations especially those related to military disengagements.

As disarmament progressed to higher stages, the IDO would be strengthened to ensure its capacity to verify the measures undertaken during these stages. The IDO would continue to operate on the completion of Stage III.

The primary method of verification employed in the draft treaty is on-site inspection by the IDO. Selective and progressive/zonal forms of on-site inspection, as well as control posts, all seem to be present in the treaty at various stages. Aerial as well as ground inspections are envisaged in some situations. Declarations by parties would also be used, as well as notifications and reports to the IDO.

PROPOSAL ABSTRACT N11(A62)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   International control organization

3. Source:
   Hammond, Paul Y. "Some Difficulties of Self-Enforcing Arms Agreements". *Journal of Conflict Resolution* 6, no. 2 (June 1962): 103-115.

4. Summary:

The author argues that an international inspection organization which was assigned responsibility for gathering data would find it difficult not to be drawn into the interpretation of those facts. In the course of acquiring and processing data some interpretations would have to be made. There would also be incentive for parties to an agreement to use the prestige of the international organization to support their particular views and consequently to press it to interpret the data.

PROPOSAL ABSTRACT N12(A65)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) International control organization
   b) On-site inspection

3. Source:
   Linde, Hans A. "Organization of a 'Mixed' National and International Inspectorate". In *Security in Disarmament*, pp. 80-106. Edited by Richard J. Barnet and Richard A. Falk. Princeton, New Jersey: Princeton University Press, 1965.

4. Summary:

This article discusses the advantages and organizational requrements of mixed inspectorates. Mixed systems are contrasted with pure adversary and pure international inspection systems. Adversary inspection permits a high degree of confidence on the part of the inspecting nation while international inspection may be more acceptable to the inspected. The author contends that a mixed system of inspection can combine the advantages of both systems. Some components of the mixed system would be "adversary" and others "international".

Linde discusses several options for organizing a mixed system in relation to personnel, equipment, budget, operations, access rights, reporting procedures, administrative direction, political control and the judging of the factual evidence.

PROPOSAL ABSTRACT N13(A68)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) International control organization
   b) On-site inspection - selective
   c) Complaints procedure - referral to new international body
                           - referral to International Court of Justice

3. Source:
   Wainhouse, D.W. Arms Control Agreements: Designs for Verification and Organization. Baltimore: The John Hopkins Press, 1968, pp. 160-168.

4. Summary:

In order to avoid an excessive number of verification groups, each monitoring a separate partial arms control measure, Wainhouse proposes the establishment of a Limited International Disarmament Organization (LIDO). The responsibilities of this agency would probably not be the same for all the agreements it monitors; it must, therefore, be sufficiently flexible to cover a variety of different situations.

The structure of the LIDO will depend in large part on the number of parties to the agreements for which it is responsible and the number of agreements. It is, however, desirable that a General Conference of parties be set up. This body would meet regularly, principally to approve decisions taken by the Control Council. The Council would be small and composed of the militarily significant parties. There would be two categories of membership - permanent and non-permanent.

Initially, the Council could serve as a consultative organ and have authority to make political judgements on the findings of inspection teams. Such judgements would be the prerogative of the parties themselves or a higher international authority. The Council would also act as a forum for resolving disputes about the implementation of the arms control agreements. If negotiations in the Control Council did not resolve the problem, provision should be made for referral to the International Court of Justice.

The LIDO would have an Administrator who would be chosen by the Control Council and approved by the General Conference with the major military powers, perhaps, having a right to veto. The main duties of the Administrator would be to select LIDO staff, accept and distribute reports, supply inspection teams with common services, act as a secretariat for the Control Council and General Conference, coordinate development of the verification systems for different arms control agreements and mediate any minor administrative problems regarding inspection.

N13(AE8)

The number of staff of the LIDO must be adequate to carry out effectively and impartially the tasks entrusted to it. This need not be large, at first. If the LIDO is to supply inspectors, their appointment would need the approval of the Control Council perhaps with the permanent members of the Council having the right of veto. The main duty of LIDO observers, if participating in a reciprocal inspection system*, would be to ensure the inspections were conducted effectively. If the LIDO inspectors actually conducted the inspection, nationals of the parties to the agreement might be attached to the inspection team.

The budget of the LIDO would be prepared by the Administrator, recommended by the Council and approved by the Conference. Requirements for contributions would be apportioned among the parties by the Control Council.

Access rights of LIDO personnel participating in inspections are crucial. The extent of access inside the territory of a party would be governed by the nature of the object to be inspected and the risk involved from possible violations.

Because the LIDO is conceived of as an expanding organization, making amendments to the treaty should be relatively easy, by a simple majority of the parties plus the consent of the permanent members of the Control Council. There might as well be procedural devices for altering the obligations of the parties without formal amendments.

Like the IAEA, the LIDO should be an autonomous international organization within the UN system. Parties would retain the right to resort to the Security Council. As the scope and authority of the LIDO is expanded the LIDO might set up links with regional organizations like the OAS.

In addition to his LIDO proposal Wainhouse's book provides a good discussion of several other verification systems including:

1) the US proposal to halt production of fissionable materials for weapons purposes (ENDC/134, 26 June 1964);**
2) the Gomulka Proposals and Rapacki Plans (late 1950s and early 1960s);***
3) the US proposal for a freeze of strategic nuclear delivery vehicles (21 January 1964); and
4) the verification of stage I of the proposals for general and complete disarmament (early 1960s)****.

Part II of the book provides a conceptual discussion of verification focussing on the problems likely to arise and general priniples for handling them. Wainhouse categorizes verification

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* See discussion below for definition of a reciprocal system

** See abstract B3(G64).

*** See abstract A6(G63).

**** See: abstracts N9(G62) and N10(G62).

systems as follows:

1) External verification: These are now referred to as "national technical means".
2) Reciprocal systems (bilateral and multilateral): These are systems in which a state (or group of states) inspects another state (or group).
3) Mixed systems: Essentially these are reciprocal systems with the addition of personnel from an international body.
4) International systems: These can take several forms including verification of specific obligations, regional arms control agreements, several agreements, and a GCD agreement.

Wainhouse also identifies several basic principles applicable to any verification system. First, the size and structure of any system is determined by the functions to be performed and the techniques to be utilized. The degree of precision required, costs, logistics and communications requirements will all affect size. Structure will be affected in particular by the number of parties involved and the extent that the system will impinge on national security interests.

Staffing will involve problems such as direction of staff, criteria for selection, recruitment, conditions of employment, privileges and immunities. Operational and support arrangements must also be considered particularly regarding which objects to inspect as well as what to do when a host state contests the right of inspection. Questions of freedom of movement, communications and logistics arise here. In addition, arrangements for financing the verification system must be specified.

Wainhouse's book also includes chapters dealing with the role of national intelligence in verification and the handling of violations.

N14(G73)

PROPOSAL ABSTRACT N14(G73)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) International control organization
   b) International exchange of information
   c) Complaints procedure - referral to new international body
      - referral to Security Council

3. Source:
   Sweden. CCD/PV. 601, 16 April 1973.
   See also: CCD/PV. 610, 5 July 1973.

4. Summary:

Because of the dangers of ad hoc methods and the need for consistant watchfulness over progress in the disarmament field, there is a need for some organizational framework to undertake verification of arms control agreements. The intent here is to rejuvenate old ideas on a general International Disarmament Organization (IDO). Sweden makes reference in this context to the American and Soviet proposals of 1962, to the Standing Consultative Committee of SALT I, to the Arms Control Agency of the WEU and to the review conference provisions of a number of arms control agreements. Sweden acknowledges the problem of establishing a control organ covering existing multilateral treaties with their different adherents.

Any such IDO, according to Sweden, must refrain from combining investigatory and judgemental tasks. Ultimately complaints must be referred to the Security Council. To realize this IDO, a two tier structure, is proposed. First, an intermediary type of IDO would be created, serving parties to various treaties by providing a two-way channel for both receiving and distributing information which is pertinent to the implementation of disarmament measures. This body would function as a clearing house for knowledge on matters relating to implementation.

The second tier of the system would be composed of a number of specialized agencies which would conduct actual investigations. These could include presently existing bodies such as the IAEA and WHO. The IDO would itself not undertake investigation but would assign specific tasks to these specialized agencies.

PROPOSAL ABSTRACT N15(A74)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) International control organization
   b) International exchange of information
   c) Remote sensors
   d) Complaints procedure
   e) Literature survey

3. Source:
   Myrdal, A. "The International Control of Disarmament". Scientific American 231, no. 4 (October 1974): 21-33.

4. Summary:

This is a proposal for the creation of an International Disarmament Control Organization (IDCO) under UN auspices "charged with the collection and dissemination of information regarding the fulfillment by the nations of the obligations they incur under disarmament agreements and regarding ongoing changes in national armaments". It is based on a before-the-fact theory of deterrence whereby the risk of disclosure of violations would serve to deter violations in the first place. The widespread collection and dissemination of information regarding world armaments and disarmament is seen as fostering a climate of openness in which trust could lift some of the burden of foolproof assurance of compliance prevalent under other verification systems.

Specifically, the IDCO would be "organically and hierarchically built up from the national level to various international levels". The broad base for the information gethering function of the IDCO would be national means of detection and verification used for both internal and international purposes. This would include pertinent satellite surveillance data. The machinery needed for control at the national level would be handled by each state, with the IDCO collating and publishing all collected data. In short, the IDCO would act as a clearing house for information derived from all sources including economic and trade statistics, all manner of open publications, and so on.

The IDCO would also be charged with investigating instances of suspected violations of agreements, although as an investigative organ, it would refer actual charges to the UN Security Council.

N16(A78)

PROPOSAL ABSTRACT N16(A78)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   International control organization

3. Source:
   Goldblat, J. "Monitoring Arms Control: Do We Need a Global Verification Institution". In Opportunities for Disarmament, pp. 69-78. Edited by J.M.O. Sharp. New York: Carnegie Endowment for International Peace, 1978.

4. Summary:

The author reviews verification provisions of twelve post-1945 arms control agreements. He concludes that in spite of elaborate provisions, the verification procedures suffer from a lack of consistency. He points out that many sophisticated technical means of verification are available only to a few states at present. Consequently, the consultation procedures included in many treaties may be of little value to countries unable to obtain information. He also questions the utility of using the UN Security Council as a forum for complaints about compliance. The procedures included in the ENMOD Convention*, however, are a first step toward separating international fact-finding from UN political judgement, which is one of the weaknesses of reliance on the Security Council. In sum, apart from the use of the IAEA to verify compliance with the Non-Proliferation Treaty, verification of arms control agreements remains a monopoly of the great powers. As more significant arms control agreements are concluded, there will be more emphasis on the problem of providing information on compliance to smaller powers.

Institutions to deal with the verification of specific arms control agreements can be set up either as autonomous bodies or as parts of existing international agencies (eg. IAEA). There have also been suggestions for a global agency to cover all arms control agreements. Such a body, it is generally agreed, would be necessary to monitor a general and comprehensive disarmament agreement. However, it is a moot question whether it would be necessary with respect to disparate, partial measures. Advocates of this approach claim that dissemination of arms control information must be institutionalized and centralized to build confidence. Goldblat argues, on the other hand, that such an all encompassing disarmament organization would have little to do regarding existing agreements since they are unlikely to be violated. New conventions such as one on CWs, will (like the NPT) require

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* See abstract M11(G77).

specialized expert bodies for verification. Nor do regional agreements require a world-wide verification organization. Furthermore, regarding the dissemination of arms control information, the UN Secretariat and the newly created UN Center for Disarmament perform this role.

It is worthwhile to consider the possibility that in the future the Centre for Disarmament might perform some auxiliary functions related to the implementation of agreements on arms control. It might, for example, assume the role of coordinator of operations conducted by specialized bodies directly involved in verification of different agreements.

PROPOSAL ABSTRACT N17(G78)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   a) International control organization
   b) Non-physical/Psychological inspection

3. Source:
   Italy. "Working paper on international mechanisms for disarmament". CCD/568, 25 April 1978.
   See also: - CCD/PV. 784, 25 April 1978.
   - CD/PV. 3, 25 January 1979.

4. Summary:
   There should be established within the framework of the United Nations, an international verification organ to supervise at a technical level and from a legal standpoint, the implementation of arms control agreements. In order to fulfil its mandate the organ should be able to employ all the most recent techniques afforded by science which would assist in ensuring strict, objective and effective international control. Examples of such verification techniques are "sensing, sampling, recording, communicating and interpreting devices".

   In CD/PV. 3 Italy reaffirms its belief in an international verification organ designed to offer coherent and adequate solutions from a technical and legal angle. Italy also suggests that it would be desirable for international verification to be accompanied by national controls exercised by public opinion over national governments.

PROPOSAL ABSTRACT N18(G78)

1. Arms Control Problem:
   Any arms control agreement

2. Verification Type:
   International control organization

3. Source:
   Sri Lanka. "Working paper submitted by Sri Lanka on the establishment of a World Disarmament Authority". A/S-10/AC.1/9/Add.1, 8 June 1978.

4. Summary:
   Sri Lanka calls for the establishment of a World Disarmament Authority as a permanent institution of the UN system. Among its tasks would be the collection and collation of existing information relating to armaments, their production, distribution, transfer, and application. The other major role of the Authority could be the implementation and monitoring of existing disarmament measures as well as those to be negotiated in the future. The Authority could also provide many countries with specialized knowledge on technical aspects of disarmament now available almost exclusively to the Great Powers.

   In the context of general and complete disarmament, the Authority could be entrusted with responsibility for controlling and regulating the production and distribution of armaments and determining the purposes for which such armaments are required. It could also give effect to decisions of the Security Council and other organs of the UN.

CHAPTER O

REVIEW CONFERENCES

Like complaints procedures, and international control organizations, review conferences form an element in a verification system, though they are not themselves correctly described as a verification "technique". The purpose of a review conference is to assure the parties to an arms control agreement of its continued effectivenss, by providing for a broad examination of whether or not the aims of the agreement are being achieved. Such an examination might include an evaluation of the effectiveness of the control and verification systems incorporated into the agreement. Any deficiencies which had arisen might be pointed out and perhaps improvements made. The resulting changes might involve resolution of relatively minor administrative difficulties or more far-reaching amendments to the treaty provisions.

Consideration of new developments in science and technology has been suggested as a function of the review conference. Since verification often involves the use of highly sophisticated modern technology, the verification system of an arms control treaty may be substantially affected by scientific and technological developments. New methods of detection may have emerged whose use, either in conjunction with or in lieu of the existing verification means, could improve the effectiveness of the verification system. On the other hand, new methods of evasion may have been developed which could increase the chance of avoiding detection. In this case additional techniques might have to be added to the verification system if sufficient confidence in its deterrence value is to be maintained.

The review conference also can play an important role in defining the scope of the arms control problem with which the treaty is intended to deal. New aspects of the problem may have surfaced or a new urgency with regard to familiar problems as yet inadequately resolved may have become more evident. Such developments can have important consequences for the verification and control systems by imposing new demands on existing procedures and by requiring modifications to be made to the old system. Cases in point are the review conferences of the Non-Proliferation Treaty: developments in a number of non-nuclear weapons states have placed new urgency on the extension and improvements of IAEA safeguards with regard to nuclear facilities and on the monitoring of peaceful nuclear explosions by some international body.

It has been suggested that if some form of permanent international control organization is created then provision in a treaty for a review conference would be unnecessary as the functions carried out by such a conference could be undertaken by the international organ. Such an organ would ideally evaluate the verification system continually and have the power to alter its administration if necessary.

It is a moot point whether there actually exists much difference in terms of efficacy between an international control organ which continually monitors and, when necessary, modifies the verification system, and reliance on a periodic review conference which conducts an <u>ex post facto</u> evaluation by providing a forum where complaints about the system can be raised. The former method has the advantage in theory of, perhaps, being more impartial and faster reacting. On the other hand, problems would impede achieving agreement over the establishment of the international body. In fact, the creation of such an organ does not seem practicable at present.* Also, it is likely that major modifications of the verification system would still require a formal meeting of the parties. One must question, as well, whether a fast reacting organ is really necessary in this context.

On the other hand, the review conference concept faces the problem of being founded on national evaluations of the verification scheme's performance. Many states may not possess a national capability to effetively do this. This problem might be rectified if an international body was given limited power to conduct an evaluation of the verification system and to make a report to the parties at a review conference. Another potential difficulty with the review conference is that it might involve a higher level of politicization of issues than an international control organ routinely evaluating the verification system.

The central issue of judging the merits and weaknesses of the review conference is whether any challenges to the verification system which arise are effectively dealt with. The NPT Review Conferences seem to indicate that problems similar to those encountered when negotiating the treaty will be encountered at the review conference and that while the review conference allows questions about the efficacy of the verification system to be discussed, it results in few, if any, concrete modifications to the verification system. This conclusion seems to be borne out by the Sea Bed Treaty Review Conference and the BW Review Conference.

Some provision for authoritatively evaluating the effectiveness of the verification system in achieving the objectives assigned to it is a valuable element in any meaningful arms control agreement. Given the difficulties over achieving agreement on the creation of an international control organ which could continuously evaluate and, when necessary, modify the verification system, a review conference, despite its limitations, would seem to be the only currently acceptable method for meeting this objective.

The actual form of the review conference provisions in existing treaties and draft treaties is fairly straightforward. The usual requirement is a meeting of the parties five years after the treaty comes into force.

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* See Chapter N.

AUTHOR INDEX

This is an index to authors of verification proposals, commentaries on these proposals and related materials. Individual authors and corporate bodies including governments and international organizations are covered. Treaties and international agreements, however, have been incorporated into the Subject Index. Full citations to the source document for each entry are given so that this index can also serve as a selected bibliography to the Compendium.

Arrangement of the entries is letter-by-letter. Sub-arrangement is by date, beginning with the earliest work by the same author. A list of abbreviations used here can be found on page x of this volume. All references are to proposal abstract numbers.

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_______. CCD/404, 5 July 1973. (CTB). *I13(G71)*

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_______. "Draft treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the sea bed and the ocean floor and on the sub-soil thereof". ENDC/269/Rev.1, 30 October 1969. *A18(G69)*

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______. CCD/377, 20 July 1972. (CBWs). *L1(G80)*

SUBJECT INDEX

This is an analytical subject index which both duplicates and expands upon the subject access to the proposal abstracts provided by the Reference Matrix on page xviii . As is true for the Matrix, two general typologies of subject terms are used to classify the proposal abstracts: terms relating to arms control objectives and terms describing types of verification systems.

Each of the terms in both these typologies is subdivided in this index according to the categories of the other typology. For example, the term "GENERAL AND COMPLETE DISARMAMENT", which refers to an arms control objective, is subdivided by the terms describing verification systems such as "On-site inspection","Literature survey", etc. Conversely, each verification descriptive term is subdivided by subject terms dealing with arms control objectives. Of course, only subdivisions for which their are entries in the Compendium are listed.

Someone interested in general and complete disarmament (GCD) will therefore be able to ascertain which GCD proposals abstracted in the Compendium include, for example, general on-site inspection as part of their verification system, simply by looking under "GENERAL AND COMPLETE DISARMAMENT" subdivided by "On-site inspection -- general". Similarly, someone interested in general on-site inspection can locate which of these proposals have concerned GCD by looking under "ON-SITE INSPECTION - GENERAL" subdivided by "General and complete disarmament". These examples demonstrate that it is important when using this subject index to be alert to the hierarchical relationships between terms. These hierarchical relationships are indicated by type face and by hyphens.

In addition, to the terms used in the Reference Matrix, several others are indexed here. The Thesaurus on page xx lists these and also indicates the hierarchical, synonymous and other relationships between terms. Also covered in this index are arms control treaties and agreements as well as selected institutions and organizations. Arrangement of the entries is letter-by-letter. All references are to proposal abstracts numbers.

AD-A124 775 COMPENDIUM OF ARMS CONTROL VERIFICATION PROPOSALS(U) 6/6
OPERATIONAL RESEARCH AND ANALYSIS ESTABLISHMENT OTTAWA
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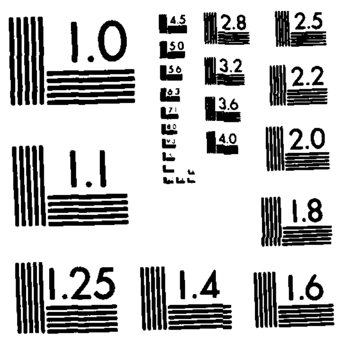

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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- *- - non-obligatory; M7(G79)*
- *- - obligatory; B49(G74), K9(G76), L11(G74)*
- *- - selective; B43(A80), B44(A80), B49(G74), B50(G76), B51(G76), B52(G77), B53(A79), B55(G79), B56(A80), B58(G81), E6(A75), K8(G76), K9(G76), L9(G73), L11(G74), M7(G79), M8(G80), N4(G79)*
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- *- - economic; E6(A75), H38(G77)*
- *- - plant; E6(A75)*
- *- - sampling; E6(A75)*
- *Remote sensors; B56(A80), L9(G73), M8(G80)*
- *- - satellite; B44(A80), H38(G77)*
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- *Short-range sensors*
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- *- - consultation and cooperation; K5(G72), K9(G76), L9(G73), L11(G74), M7(G79), M8(G80)*
- *- - consultative commission; B46(G80), B58(G81), C5(G79), K7(G72), K9(G76), L5(G72), M7(G79), M8(G80), N3(G71)*
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- *- - referral to new international body; L11(G74), N3(G71), N5(G80)*
- *- - referral to Secretary General; M3(G72)*
- *- - referral to Security Council; B46(G80), K7(G72), K9(G76), L5(G72), L7(G70), L9(G73), L11(G74), M3(G72), M7(G79), M8(G80), N3(G71)*
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- *- - sampling J2(G78)*
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13. ABSTRACT

This volume is intended to serve as a quick reference catalogue to 296 arms control verification proposals originating in the publications and statements of governments and intergovernmental bodies as well as the academic literature on the subject.

Each proposal has been abstracted and classified according to two main criteria: the arms control objectives with which it is concerned and the types of verification methods involved. Included are a Reference Matrix, a Subject Index and an Author Index which permit easy access by the reader to any proposal abstract in which he or she may be interested.

Chapters in the Compendium are organized according to methods of verification. Each chapter includes an introductory discussion of the method followed by the proposal abstracts which deal prominently with that verification method. A general introduction to the volume is also provided.

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